

SPOKANE INDIAN HOUSING AUTHORITY TRIP REPORT

Assessment of Mold and Moisture Conditions

Final Report

Date:

March 15 - 16, 2005

Prepared for:

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Office of Native American Programs

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Background Information

The Spokane Tribe's reservation is bounded on the south by the Spokane River and to the west by the Columbia River. It consists of 194,000 acres in eastern Washington, on the Colville River Plateau. Only 10 percent of the acreage is held in trust by the Federal Government. The Spokane Reservation is located in Stevens County in Eastern Washington. The Spokane Tribe has 2,415 enrolled members; about 1,375 tribal members reside on the Reservation. The average annual maximum temperature is 59.2° F; the average annual minimum temperature is 36.2° F. The annual mean temperature is 47.4° F. On average, 100.0 inches above the Fermat's Current Annual Acre (FCAA) includes 19 Low Rent units and 94 Market Rate units.

Day 1: Monday, March 14, 2005

Monday was a travel day to the reservation.

Day 2: Tuesday, March 15, 2005

On Tuesday morning, the assessment team met with the SHIA staff, then inspected three homes that morning and four more homes that afternoon. The selection of properties for inspection was not random, but picked by SHIA.

Visual assessments were conducted at each site, and digital photographs were taken to record conditions. The inspection process involved visual assessment of each interior and exterior condition, and interview of residents, where possible.

Ronda Wyne, Maintenance Manager, and Glen Gotsch, Maintenance Specialist, were our primary hosts and guides on our investigation.

PART I

SPOKANE INDIAN HOUSING AUTHORITY TRIP REPORT

March 15 - 16, 2005

Introduction

Michelle Rook, Building Research Council (BRC) at the University of Illinois Urbana-Champaign (UIUC) and Robert Nemeth, Magna Systems, Inc. conducted a site visit to the Spokane Indian Reservation on March 15 to 16, 2005. The Spokane Indian Housing Authority (SIHA) administers the housing program for the Spokane Indian Reservation. The site visit provided technical assistance to the SIHA in assessing mold and moisture conditions in housing units. This report summarizes activities and issues addressed while on site. A detailed analysis of findings and recommendations is found in *PART II: Spokane Indian Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Spokane Indian Reservation*.

Background Information

The Spokane Tribe's reservation is bounded in the south by the Spokane River and in the west by the Columbia River. It consists of 154,000 acres in eastern Washington, on the Columbia River Plateau. All but 10 percent of the acreage is held in trust by the Federal Government. The Spokane Reservation is located in Stevens County in Eastern Washington. The Spokane Tribe has 2,415 enrolled members; about 1,275 tribal members reside on the Reservation. The average annual maximum temperature is 58.2° F; the average annual minimum temperature is 36.6° F. The annual mean temperature is 47.4° F. Currently, HUD records show the Formula Current Assisted stock (FCAS) includes 109 Low Rent units and 94 Mutual Help units.

Day 1: Monday, March 14, 2005

Monday was a travel day to the reservation.

Day 2: Tuesday, March 15, 2005

On Tuesday morning, the assessment team met with the SIHA staff, then inspected three homes that morning and four more homes that afternoon. The selection of properties for inspection was not random, but picked by SIHA.

Visual assessments were conducted at each site, and digital photographs were taken to record conditions. The inspection process involved visual assessment of both interior and exterior conditions, and interview of residents, where possible.

Brenda Wynne, Maintenance Manager, and Gene Brisbois, Maintenance Specialist, were our gracious hosts and guides on our investigations.

Day 3: Wednesday, March 16, 2005

On Wednesday morning three more homes were inspected. The afternoon was spent in a meeting with the housing and maintenance staff to discuss mold problems, their causes, and strategies to resolve them.

Day 4: Thursday, March 17, 2005

Thursday was a travel day back to Illinois.

The attached *Part II: Spokane Indian Reservation Technical Housing Assessment Report* provides a detailed analysis of findings and recommendations for the homes investigated.

MOLD TESTING

The assessment team agrees that if there is mold inside a building, it should be cleaned up. Generally, identifying the species of mold growing in a residence is unnecessary. No baseline exists for acceptable or unacceptable mold concentrations in a home. This message concurs with other federal agencies and experts as documented below.

Attachment 1 is a copy of *The Measurement Problem Regarding Mold*.

The Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section (BAIHS EHSS), *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, takes this position on testing:

Consistent with Center for Disease Control (CDC) and Environmental Protection Agency, BAIHS EHSS does not recommend testing as the first response to an indoor air quality concern. Instead, careful detailed visual inspection and recognition of moldy odors should be used to find problems needing correction. Efforts should focus on areas where there are signs of moisture or high humidity or where moisture problems are suspected. The investigation goals should be to locate indoor mold growth to determine how to correct the moisture problem and remove contamination safely and effectively.

The Adverse Human Health Effects Associated with Molds in the Indoor Environment by the American College of Occupational and Environmental Medicine, states that to successfully remediate mold and moisture conditions, the water and moisture sources must be identified and corrected.

Mold spores are present in all indoor environments and cannot be eliminated from them. Normal building materials and furnishing provide ample nutrition for many species of molds, but they can grow and amplify indoors only when there is an adequate supply of moisture. Where mold

grows indoors, there is an inappropriate source of water and moisture that must be identified and corrected before remediation of the mold colonization can succeed. Mold growth in the home, school, or office environment should not be tolerated because mold physically destroys the building materials on which it grows, mold growth is unsightly and may produce offensive odors and mold is likely to sensitize and produce allergic responses in allergic individuals. Except for persons with severely impaired immune systems, indoor mold is not a source of fungal infections. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school, or office environment.

BAIHS EHSS Guidelines on Assessment and Remediation of Fungi in Indoor Environments discusses the limitations of testing as follows:

Mold testing only provides a snap-shot estimate for a single point in time and a single location. How well the test represents other locations and times is uncertain since the amounts and types of mold in the environment are always changing. Furthermore, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. The variability can be especially large for airborne molds, with significant changes occurring over the course of hours or less. Caution must also be used in interpreting surface testing results, since mold growth or deposition may not be uniform over an area and may increase or decrease as time passes. Unless many samples are taken over a period of time and the investigator has been mindful of building operations and activities during the testing, the results might not be very representative of typical conditions; in addition, tests reflecting typical conditions may also miss evidence of problems that only occur infrequently (water leaks during rain storms).

Mold testing is often expensive. Dollars spent on unnecessary testing reduce the amount of money available for remediation and repairs. The following web sites and references provide further information on mold remediation and testing:

Indoor Air Quality

Ball State University Indoor Environment Notebook - General resource on a number of topics related to indoor air quality.

http://publish.bsu.edu/ien/archives/archive_list.htm (will open a new browser window)

Mold

EPA - Mold Remediation in Schools and Commercial Buildings

<http://www.epa.gov/iaq/molds/index.html> (will open a new browser window)

New York City Department of Health Bureau of Environmental & Occupational Disease Epidemiology - Guidelines on Assessment and Remediation of Fungi in Indoor Environments
<http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html> *(will open a new browser window)*

References

Guidelines on Assessment and Remediation of Fungi in Indoor Environments, Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section

The Measurement Problem Regarding Mold, by William B. Rose, Research Architect, Building Research Council/School of Architecture, University of Illinois, Urbana-Champaign Campus, 2003.

Adverse Human Health Effects Associated with Mold in the Indoor Environment: Position Statement by Hardin, Kelman, and Saxon, American College of Occupational and Environmental Medicine, 2002.

APPENDIX C: IMITATIONS OF MOULD SAMPLING

The Measurement Problem Regarding Mold
 By William B. Rose, Research Architect
 Building Research Council/School of Architecture
 University of Illinois, Urbana-Champaign

When complaints of mold problems occur, two courses of action are appropriate: 1) identify and fix the site, remove the mold, and correct the conditions that led to the mold, and 2) assist health professionals for allergy or respiratory problems. The proper action is to eliminate sites of mold growth. Where this approach has been used, the number of complaints in every case, improvement of indoor environment conditions (though the improvement may vary), and improvement in health conditions. This is the recommended approach for dealing with mold problems in housing in trouble areas.

Attachment 1

Techniques for sampling biological aerosols were developed for industrial and agricultural settings. They were designed to help industrial hygienists determine the safety of environments and other environments. The value of their work was evident in determining the cause of the Legionella outbreak of 20 years ago, and in sampling for biological warfare agents in general. Sampling procedures count of mold spores from air samples taken in the air or on surfaces. It may determine the number of viable spores in a sample from the count of viable. And it may be used to identify growth and spread of mold from a sample.

Neither of the two recognized guidelines for mold remediation, the NYC Department of Health's *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* and the UKHSA's *Mold Remediation in Schools and Commercial Buildings*, calls for environmental sampling for indoor mold problems. Both guidelines discourage environmental sampling in most cases. This approach is summarized on the CDC website:

Generally, it is not necessary to identify the species of mold growing in a remediated mold. CDC does not recommend routine sampling for molds. Current evidence indicates that allergies are the type of disease most often associated with mold. From the susceptibility of the victims can vary greatly other diseases. The growth of mold, sampling and controls are not reliable in identifying mold. The CDC website states that "reliable sampling for mold can be expensive, and methods for sampling mold are not well understood or available in many cases."

In general, the CDC website sampling mold is discouraged. There are several reasons for this. First, mold is not a health hazard. The health outcomes of mold in homes, schools or offices have not been established. Second, given the circumstances there is no basis for testing for mold in homes or schools. Third, the health outcomes of mold are not well understood. Fourth, the health outcomes of mold are not well understood. Fifth, the health outcomes of mold are not well understood.

APPENDIX C: LIMITATIONS OF MOLD SAMPLING

The Measurement Problem Regarding Mold

By William B. Rose, Research Architect
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When complaints of mold problems occur, two courses of action are appropriate: 1) visually assess the site, remove the mold, and correct the conditions that led to the mold and 2) contact health professionals for allergy or respiratory problems. The proper action is to discover sites of mold growth. Where this approach has been used, the outcome has been, in every case, improvement of indoor environment conditions (though the improvements may take time) and improvement of health conditions. This is the recommended approach for dealing with mold problems in housing in Indian areas.

Techniques for sampling biological aerosols were developed for industrial and agricultural settings. They were designed to help industrial hygienists determine the safety of workplaces and other environments. The value of their work was evident in determining the causes of the Legionella outbreak of 20 years ago, and in sampling for biological warfare agents at present. Sampling produces counts of mold material from samples taken in the air or on surfaces. It may determine the number of viable spores in a sample from the air or a surface. And it may be used to identify genus and species of mold found in the sample.

Neither of the two recognized guidelines for mold remediation, the NYC Department of Health's *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* and the USEPA's *Mold Remediation in Schools and Commercial Buildings*, calls for environmental sampling for routine mold problems. Both guidelines discourage environmental sampling in most cases. This opinion is summarized on the CDC website:

Generally, it is not necessary to identify the species of mold growing in a residence, and CDC does not recommend routine sampling for molds. Current evidence indicates that allergies are the type of diseases most often associated with molds. Since the susceptibility of individuals can vary greatly either because of the amount or type of mold, sampling and culturing are not reliable in determining health risk . . . reliable sampling for mold can be expensive, and standards for judging what is and what is not an acceptable or tolerable quantity of mold have not been established.

In general, the use of mold sampling must be discouraged. There are several reasons for this. First, aside from allergic effects, the health outcomes of mold in homes, schools or offices have not been established. Second, given those circumstances, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. Third, the internal repeatability of mold sampling results has not been shown in the literature. Fourth, weaknesses in the visual assessment protocols have not been demonstrated.

Mold sampling has been done in residential settings, leading to conclusions about the presence of mold, about the presence of individual species of mold, and about high concentrations of mold in some locations. However, much of the information provided by sampling is already known from common sense. The following are some facts about mold in indoor environments that are known even before measurements are taken:

1. Mold is everywhere. The outdoor air contains rather high concentrations of mold spores, which are naturally occurring. By contrast, most building interiors contain lower concentrations, though the concentrations indoors and outdoors vary over time. Indoor air comes from the outdoors. If the indoor is cleaner than the outdoors, something served as a filter, accumulating mold, dust and airborne material over time. Some commercial buildings have filtration systems designed to clean air as it passes from outdoors to indoors. But in most buildings, the outdoor air infiltrates through cracks and cavities in the building envelope as it travels indoors. If the indoor air is cleaner, then the building envelope acts like a filter. Therefore, when a sample of indoor air is taken, mold spores will be found. The conclusion "This building has mold" can be made of all buildings.
2. Dust, dirt, mold spores and other particulates accumulate in building cavities over time. There is no passive cleaning process for building cavities to match this cumulative process. Because the walls and roofs filter outdoor air as it moves indoors, all building cavities must be considered as sites with high concentrations of mold spores and other airborne material.
3. Evidence indicates that where proper conditions are in place, sooner or later the species that typically inhabit such spaces will arrive. *Stachybotrys* is known to inhabit pulpy cellulose materials that are maintained at a high water activity level. With the right quantity of water, the paper facing of gypsum products generally shows the growth of *Stachybotrys*. Where the appropriate conditions are maintained for a long enough time, *Stachybotrys* and other species appear and grow. "Wet it, and they will come."
4. It is logically impossible to prove a negative statement. There are no tests that allow one to draw the conclusion that absolutely no mold spores representing a species are to be found in a space. Even if a test should turn up no spores of a given species that does not provide conclusive evidence of the total absence of that species from the interior space. And conditions may change from one hour to another. So a finding in a room or building of any given species, including *Stachybotrys*, should not be considered exceptional. The absence of a species from a space can be determined statistically to a pre-selected degree of confidence, requiring several tests.

What, then, remains to be discovered through mold measurement? It is already determined, for all buildings, that mold is contained in the air, that any species may be found in the air or on the surface, and that high concentrations of mold are contained in the cavity. If a tenant or occupant complains about living conditions, it is clear that any unit that occupant will move to will have mold in the air, will have all common species of

mold in the air or on surfaces, and will have high concentrations of mold in the building cavities. It is wrong to presume that buildings are sterile simply by virtue of their never having been measured.

Measurements of mold are not useful if the purpose of the measurement is to determine any or all of the following:

- 1) if the building has mold,
- 2) if a certain species, say, *Stachybotrys*, is present, or
- 3) if the building cavities have high concentrations

For the measurement criteria above, no measurements should be made, as the results will be dismissed as being of no use.

Possible Occasions for Mold Measurement

After the effective implementation of visual assessment and remediation of mold as described above and conditions of mold are suspected to still exist, it is possible (though unlikely) that a visual assessment will overlook a cause of distress. If that happens, one strong possibility is that the distress is not related to mold in the first place. However, in the case where a mold problem has not been accurately identified and remediated through visual assessment, three scenarios are often suggested as possible occasions for mold measurement:

1. Active mold growth is usually accompanied by amplification, the strong increase in mold of one or two species out of proportion to the background taxa.
2. Mold may have an odd source, such as air conditioning ductwork, and may be present in the building only when that source contributes to the space, or
3. An investigator may use a fixed level as a measure of acceptability or cleanliness (though it bears repetition: there are not exposure limits set by any authorities).

In each of these cases, mold measurement may be able to provide some insight.

The statistics of mold measurement

For mold measurement to provide insight, or to provide material for decision-making, the results of mold testing must be statistically significant. One measurement is never statistically significant. Understanding the notion of statistical significance requires understanding error and bias.

Two samples of the same space will never provide the same results. There is always some spread (or precision error) in the data. The mold sampling industry generally fails to make public their estimates of the precision error in their sampling methods. It would be good to know, for the same equipment, same operator, same laboratory, same technician, what the estimate of the error would be. That information is not presently available. In

addition to precision error, there are many other factors that tend to bias the results one way or another. These include the following:

1. Time of the day (ascomycetes tend to release spores in the afternoon, basidiomycetes in the morning)
2. Season (lower during winter)
3. Snow cover (greatly reduces outdoor concentrations)
4. Sampling technique (lowest with culturable samples, medium with impactors, highest with PCR)
5. Variations over space (highest, usually, in basements and crawl spaces)
6. Variations by surface (highest near carpets)
7. Disturbance (greatly higher with scuffing and fluffing of carpets, etc.)
8. Variations by wetness (higher concentrations on wetter materials)
9. Laboratory
10. Technician

It is evident that achieving statistically significant results requires considerable care, in addition to thoroughly accounting for variables. All proposals for mold study that involve sampling must contain information that describes:

1. The yardstick, or baseline values, that will be used for interpretation,
2. The variables that are accounted for in the study,
3. The error estimate associated with those variables,
4. The confidence interval to be used (95% confidence in the results is recommended),
5. How the study will deliver that level of confidence.

Sampling campaigns that give numbers without giving statistical significance to those numbers are worse than worthless. They come at a financial and social cost and are very disruptive to the lives of individuals, families and tribes.

The range of concentrations often found in mold measurements is several orders of magnitude—sometimes several dozen spores or colony-forming-units (CFUs) per unit of mass or volume out to several million. Most guidance advises representing the distribution as lognormal; that is, if the data values are represented not as numbers with zeroes but as powers of ten, then the exponents occur in a normal distribution. This is quite helpful, as one of the tails of the distribution never drops below zero.

Let us presume that an environmental consultant hypothesizes that the airborne mold spore concentration in a room exceeds a certain value. Of course, the consultant would be obliged to cite the reference for the value selected. Taking a single sample gives a distinct reading for the sample but says nothing about the concentration in the room. A second sample, with a result different from the first, proves that a single sample cannot characterize the actual concentration. Also, clearly, the more samples that are taken, the more sure one can be that the mean of the measured values represents the actual value, and can be used in this comparison test.

Let us also presume that the confidence interval used is 0.05 ($\alpha = 0.05$). That means that 5% of the time the confidence in the veracity of the finding will be misguided. Nevertheless, many scientific and management findings use a 0.05 confidence interval. Tribal leaders or others who are entertaining proposals from environmental consultants might consider having a stated confidence interval at the time of the work proposal, perhaps of 5%.

Then standard statistics allows us to calculate the confidence interval. The result is usually expressed as a value $y \pm z$ ($\alpha = 0.05$). The value y is the mean (average) of the sample values. The value z is composed of the Standard Error (SE, equal to the standard deviation divided by square root of the count-1) times a factor called "student's-t" (t). This factor is commonly used in statistics when the number of samples is small; it is found in textbooks of statistics and as a common spreadsheet function. The value z is equal to $(t) * (SE)$.

An environmental consultant may wish to sample to determine if a certain species is present or not. Common species of mold should always be deemed to be present, but may be proved to be absent, if indeed they are absent, to any selected degree of confidence (never for certain).

Testing is expensive. So there is a strong tendency on the part of both consultants and clients to conduct testing without regard to the statistical significance. This practice should end, as the results cannot be used for decision-making. If testing is to be done at all, then the testing campaign must be designed to have the power to provide answers to the critical questions.

All mold testing must include a minimum of two samples per measurement site. Taking only one sample leaves the impression that the value is somehow elevated above error. With two samples per site, the issue of error is inescapable. In addition all mold testing should:

- State the question or hypothesis that is being answered or addressed through testing
- State the criteria (absolute or comparison) used to address the hypothesis
- State the proposed confidence level.
- List the errors and biases that are accounted for (or controlled for) in the testing.
- Calculate the margin of error.
- Report the findings with the margin of error.
- Attach statistical significance to the conclusions.

July, 2003

PART II

SPOKANE INDIAN HOUSING AUTHORITY

TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES OF THE SPOKANE INDIAN HOUSING AUTHORITY

Executive Summary

Introduction

Section 1: Methodology

Section 2: Spokane Indian Housing

Section 3: Findings

Section 4: Technical Discussion and Recommendations

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results

EXECUTIVE SUMMARY

The assessment team inspected ten homes on the Spokane Reservation for moisture and mold conditions. The ten principal findings include:

1. The maintenance division of the Spokane Indian Housing Authority determined that many of the problems identified during the site visit stemmed from improper construction or from residents choosing to not use bath fans.
2. Nine inspected homes had mold; in some homes the mold was negligible and in other homes it would require remediation.
3. The most common problem leading to mold was poor bathroom ventilation. Marginal bathroom fans coupled with such undersized soffit vents that very little air exhausted from the bathroom. Poor bathroom exhaust ventilation can result in significant interior moisture loads. This can increase the potential for mold growth, particularly in homes with high occupancy rates.
4. The sealing of crawl space floors ranged from very good to poor. One crawl space had standing water.
5. Only the new homes, which were not viewed, had furnaces. Most of the older homes relied on wood stoves, located in the living room, for heat. In several instances, bedrooms that were remote from the heat source had mold. Poor heat distribution can contribute to mold problems, because remote spaces stay cold and have a much higher humidity than areas immediately surrounding the stove/heat source. The homes all had (point source) electric heat in every room, but most residents stated that they did not use it.
6. Three homes had plumbing problems, such as leaky vanities and kitchen sinks. Fortunately, the leaks had not yet caused major cabinet deterioration and mold. All leaks were fixed during our assessments.
7. Several homes had unvented crawl spaces that, through open ductwork, were in direct contact with the living spaces. This raises concerns for radon exposure.
8. The various kitchen range hoods vented to the exterior or attic and other inappropriate places leaving many possibilities for mold or moisture problems.
9. All the attic hatches were insulated. In most instances, attic insulation was very consistent across the attic and was well installed.

INTRODUCTION

Michelle Rook from the Building Research Council at UIUC and Robert Nemeth from Magna Systems, Inc. inspected ten units for mold and moisture problems for the Spokane Indian Housing Authority (SIHA) on March 15 - 16, 2005. The inspection process of the homes involved visual assessment of both interior and exterior conditions and interview of residents, where possible.

The homes included two split-level and eight ranch style homes on crawl spaces. The homes ranged in age from fifteen to twenty-five years old.

SECTION 1 - METHODOLOGY

Visual Inspection

Housing inspections consisted primarily of visual assessment of mold and moisture conditions. The assessment team used forms developed for the Chicago Mold and Moisture Project, a HUD Healthy Homes Program, organized for a room-by-room inspection. The team recorded information on water damage and evidence of mold for all rooms inspected. Additionally, the team inspected the plumbing, localized ventilation, water entry and other moisture source issues in kitchens, bathrooms, basements, crawl spaces, utility rooms and attics.

The home exteriors were inspected for rainwater/snow melt management; this includes site grading, roof condition and gutter system.

Whenever possible, the team interviewed occupants to gather history on moisture problems, plumbing leaks, winter condensation, health issues, number of occupants and other useful information. Digital photographs visually recorded notable conditions at each home.

The results of the mold and moisture assessments were compiled on a spreadsheet, with broad categories of common moisture problems noted. This data is presented in Appendix A in this report. The findings from individual house inspections are presented in Appendix B.

SECTION 2 – SPOKANE INDIAN RESERVATION HOUSING

The SIHA maintained 109 Low Rent (LR) units, 94 Mutual Help (MH) units, and 25 Tax Credit units of Tribal housing. The assessment team examined ten LR and MH housing units for mold and moisture specifically selected by the SIHA. The homes were all stick-built with 2x6 wall framing and trussed roofs.

The Reservation has a mix of older tri-level and single story, ranch style homes. The lower levels of the tri-level units were partially sub-grade, by approximately four feet. The middle levels, of the tri-level homes, were constructed over cast-in-place crawl

spaces. The single story, ranch style homes were constructed over cast-in-place concrete crawl spaces that were approximately four feet deep. They had trussed roofs with gable ends.

SIHA recently built a new subdivision of twenty-five homes that was funded through tax credits. These were a mix of one and two story homes and a community center.

SECTION 3 – FINDINGS

The assessment team found visible mold growth, ranging from slight to substantial in nine inspected houses. Mold contamination is always associated with moisture problems. Nine general findings based on the inspection follow.

3.1 Exterior Site Drainage and Rainwater Management

Good site drainage and rainwater management is essential to maintaining dry foundations and houses. Site drainage was satisfactory at most homes. Most sites were flat close to the home, but dropped away further from the home. Four homes had depressions near the foundations.

Many homes did not have gutter systems. Those that did were filled with pine needles. In wet climates, the lack of a gutter system can place a tremendous moisture load on the foundation and the house. However, it did not appear to pose a problem in this particular climate. The Spokane Indian Reservation receives less than twenty inches of precipitation per year. SIHA mentioned that remaining gutter systems were going to be removed because of the constant pine needle buildup (Figure 1).



Figure 1: Pine needles in gutters and missing downspout

All the homes had approximately 16 inches of overhang on the front and back, which helped shed water away from the building.

Section 4.1 provides a detailed discussion of site drainage and rainwater management.

3.2 Elevation of Home above Grade

All inspected homes were built close to grade, which frequently contributes to several moisture related problems. When the siding is only eight to ten inches above grade, rainwater that drains from the roof onto the ground splashes onto the siding and saturates it. Snow accumulation adjacent to a home provides another source of moisture. As snow accumulates against the siding, the warmer siding absorbs the moisture. Neither condition

of water splashing onto the siding or snow accumulation next to the house appeared to be a problem in Spokane. The roof overhangs appear to be functioning well at keeping moisture away from the base of the buildings.

However, in homes with only a few inches of foundation appearing above grade, the crawl space vents were placed in the rim joist rather than in the foundation wall (Figure 2). Placing the crawl space vent in the rim joist positions the vent directly beneath the plywood subflooring. Cold air entering the vent can chill the floor above and cause localized cold spots on the floor and adjacent wall. Mold can grow in these chilled areas.

3.3 Crawl Spaces

Most homes with crawl spaces had an effective vapor barrier (VB) (Figure 3) to keep ground moisture from dissipating up into the structure. None of the inspected crawl spaces had separate sheets of VB sealed to one another. Although this may not be a significant issue in regard to moisture, it is with radon. Radon is a gas which should be contained beneath the VB or vented to the exterior. Sealing individual pieces of VB to one another and sealing along the VB perimeter is important. This is particularly an issue



Figure 2: Crawl space vent through band joist

in the housing units with sealed crawl spaces and ductwork connecting the crawl space with the living space. In these homes there was a fan in the attic that drew air from the crawl space and exhausted it into the attic. Replacement air for the crawl space was drawn through three ducts that connected to the living space. The fan in the attic was controlled by a humidistat, located in the crawl space. When the humidistat triggered the fan to turn on, it drew air from the crawl space, which was then replaced with air from the living space. Some potential problems with this crawl space ventilation strategy include:

1. A negative pressure in the living space may be caused when an exterior door is opened, when a window is opened on the leeward side of a house or when a bath fan is turned on. When this negative pressure exists, air can freely migrate from the crawl space into the living space carrying with it any pollutants present in the crawl space.
2. If the dryer duct becomes disconnected in the crawl space and pressurizes the crawl space, air and any pollutants present in the crawl space can be forced up through the ducts into the living space.



Figure 3: Well installed vapor barrier

3. Moist air exhausted into the attic can condense on cold surfaces, as evidenced by the (formerly) wet insulation surrounding the fan unit (House 1-6 & 2-1)

Refer to the following EPA website for more information on Radon and Radon mitigation techniques: <http://www.epa.gov/radon/pubs/index.html>

The crawl spaces were insulated with rigid insulation, attached to the upper portions of the foundation stem wall. Most of the insulation was still in place, but some pieces had come loose and had fallen onto the crawl space floor. The rim joists were insulated with fiberglass batt insulation, but certain hard to access areas were left uninsulated. Some of these uninsulated areas had mold problems below and above the plywood subflooring.

One of the crawl spaces had standing water. The source of water was probably from a leaking fire hydrant in front of the house. There was standing water on the ground around the fire hydrant, and the ground was saturated with moisture. This neighborhood also experienced problems from snowmelt run-off from a nearby hill. The impervious granite stratum keeps water from draining, causing it to remain at the surface and fill crawl spaces.

Mr. Richard Garry, the Development Manager, mentioned that in the new housing project the platform was insulated rather than the stem walls. Section 4.2 discusses the differences between insulating the stem wall versus the platform.

3.4 Winter Moisture Condensation

Winter moisture condensation caused mold in nine homes. Mold growth was visible in bedroom closets, at the wall/ceiling junctures of exterior walls in bathrooms, and at the base of exterior walls. Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point (temperature at which dew begins to form or vapor condenses into a liquid) of the air. This problem indicates a combination of two factors:

1. High wintertime moisture load (relative humidity).
2. Lower than desired interior temperature.

Lowering the moisture load and/or insulating or heating surfaces to prevent cold surface temperatures can resolve the problem. Section 4.3 discusses condensation issues. The following three findings relate to the condensation problem.

3.5 Bathroom, Kitchen and Dryer Exhaust Ventilation

One home had an inoperable bathroom fan (Figure 4), one home had a bathroom fan that vibrated excessively and was



Figure 4: Inoperable bath fan

therefore not being used, and six homes had bathroom fans that did little more than make noise. Bathrooms experience high moisture loads and often develop localized mold problems. Typically, bathrooms show the first signs of mold growth because of their recurring high moisture load. Bathroom ventilation can reduce the interior moisture load. Most of the bath fan ducts terminated at the soffit and exhausted through a small soffit vent. The vent was far too small to exhaust an adequate quantity of air. In a couple of instances, the placement of the vent was adjacent to soffit vents for attic ventilation (Figure 5). These vents should be located remote from one another so that warm moist air being exhausted by the bath vent does not migrate up into the attic.

There was a mix of range hood types in the homes visited. Most exhausted to the exterior, two were recirculating, and one never worked. Venting to the exterior is particularly important in homes that have a gas or propane range; this is due to the pollutants, the moisture and the byproducts from the combustion process.

A disconnected dryer duct was found in one home (Figure 6). The dryer vented into the crawl space, and probably provided the source of moisture which caused problems throughout the home.

Section 4.5 discusses bathrooms and localized exhaust ventilation in greater detail.

3.6 Overcrowded Conditions

High occupancy rates are fairly common in Native American housing. Overcrowded homes have increased moisture levels from human sources. This contributes to elevated interior moisture loads, and can lead to mold contamination from condensation. Overcrowding also contributes to more personal items being located inside the home. Those that are stacked against walls act as insulation, further reducing the temperature of the wall surfaces.

Detailed discussion of human moisture sources is found in Section 4.6.

3.7 Heating Method and Heat Distribution

Most inspected homes used wood stoves, located in the living room, as the primary heat source. All the homes had electric wall heaters in each room; however, most residents rarely used them. Heating method and heat distribution play a vital role in preventing wintertime mold and moisture problems. Warm air should be evenly distributed throughout the home. Remote bedrooms often have problems because they can be colder than the rest of the home, causing water vapor condensation on cold exterior walls, particularly in closets.



Figure 5: Undersized bath vent next to soffit vent



Figure 6: Disconnected dryer duct

Heating systems are discussed in greater detail in Section 4.7.

3.8 Exterior Wall/Ceiling Juncture

High indoor relative humidity during the winter can result in condensation based mold growth on a cool interior surface (Figure 7). This commonly occurs at the exterior wall/ceiling juncture, particularly on older, wood frame structures with low-sloped roof pitches. This building condition restricts careful placement of ceiling insulation (reducing R-value) and is affected by cold winds through the soffit vents that then washes through the insulation. Several homes had this problem in the bathroom, the room with the highest humidity



Figure 7: Mold at wall to ceiling juncture in bathroom

Exterior wall to ceiling issues are discussed in greater detail in Section 4.3.

3.9 Maintenance and Lifestyle Issues

The Spokane Reservation homes exhibited some occupant maintenance and lifestyle issues that contribute to mold and moisture conditions. It is important to recognize occupant education and participation is an important component of a successful program for maintaining mold-free homes.

1. Several bath fan grills were clogged with lint. Keeping the grill slots clean allows the fan to draw more air through the grill and from the home.
2. Several homes had windowsills with dirt and mold on them. It is not unusual for dust to land on window sills, since outside air transports dust and mold spores into the house. Condensation on the glass surface wets the dust, and the dust serves as food for the mold to grow. Heavy window coverings exacerbate this condition. Acting as an insulator, they lower the temperature between the covering and window, which causes increased condensation to occur. Drawing heavy coverings back during the day allows warm, interior air to circulate over the window surfaces thus drying them.
3. Occupant attention to cleanliness can reduce mold problems. Regular cleaning in bathrooms and other wet areas can reduce mold growth. See also Section 4.4.
4. Careful storage of possessions can also control mold growth. The presence of clutter in closets and against exterior walls creates conditions conducive to mold growth. By further insulating the exterior wall, the clutter increases condensation problems if sufficient moisture is present. Similar situations are created when furniture is pushed against exterior walls.
5. Modifying occupant lifestyles is as important as solving technical problems. In general, most mold problems can be resolved. However, without addressing occupant lifestyle issues many mold problems will rapidly resurface.

Maintenance issues are discussed in Section 4.8.

SECTION 4 - TECHNICAL DISCUSSIONS AND RECOMMENDATIONS

The following discussions and recommendations are based on the general findings identified during the site visit to the Spokane Indian Reservation.

4.1 Site Drainage and Rainwater Management

Site Drainage

Design and build the roof so rain moves out to the edge and falls onto a soil surface – some percolates downward through the soil—more in sandy soils and less in clayey soils. The water that does not percolate downward will move along the soil surface, following the slope, to the downhill edge of the site. Homes that allow water to accumulate in the soil that is in contact with the foundation will develop moisture problems. The best way to prevent mold and moisture problems in homes is to ensure that rainwater moves off the roof, across the site and off the property. In a well-managed property, the soil in contact with the foundation is the driest soil on the site following a rainstorm. Homes with dry foundations (basements, crawl spaces and slabs) are usually dry houses. Two general rules and some specific guidelines to keep the foundation dry by keeping the soil next to the foundation dry follow:

1. The first general rule concerns concentration – the greatest concentration of water causes the worst damage. A valley on a roof acts like a funnel, with the greatest concentration of water at the base of the valley. Gutters also act like funnels that collect water from the edge of the roof and direct it to the downspouts. On the land, valleys and swales act like collectors or funnels that concentrate the water on the site. Water management design that makes use of funnels (such as valleys, gutters or swales) requires maintenance to ensure the funnels work as intended. Frequently water damage occurs where a valley, gutter or swale is blocked.
2. The second general rule concerns the ground roof rule - treat the soil surface as if it were a low-slope roof surface. Pitch the ground surface away from the house - the steeper the pitch, the better the drainage. Develop methods to move all the water to the low edge of the site and how best to get it there. Do not allow areas to remain near the building that can act as water collectors.

Specific site drainage guidelines include:

1. Build the home on a hill, not in a hole. Sufficient exposed foundation allows for improvement by site grading at the home. If the home hugs the ground, improvements at the foundation are more difficult. A minimum of eight inches of foundation should be between the ground and the beginning of the siding.

2. Identify localized dips and holes adjacent to the foundation, fill them with dirt, and tamp the fill material to prevent future settling. Use enough of the fill material so drainage flows away from the foundation.
3. If the home has no gutters, then the base of the soil around the home has to act as a gutter. The ground surface should prevent splash back onto the siding of the home and should have enough pitch to effectively move water away from the home.
4. Good tamping or compaction of the backfill is very helpful in keeping water on the surface where it can be managed by slope. Soil at the outside corners of the foundation, where the downspouts are usually found, should always be tamped so the corners will not collapse inward.
5. Bushes and other plantings can help with drainage if their root balls soak up large amounts of water. They can be planted strategically near downspouts so that downspout extenders are less likely to be kicked off or removed during lawn mowing.

Rainwater Management

In most locations rain water management is critical to maintaining a dry foundation. Housing in the Spokane Valley is somewhat different since the dry climate and low annual rainfall (19.72 inches/year) do not contribute much moisture to the environment. All the homes have wide overhangs. These overhangs, proper ground slope, and the low rainfall make gutters a luxury rather than a necessity.

Future housing projects should include wide overhangs and soil sloped away from the foundation which make gutters unnecessary at Spokane Indian Reservation.

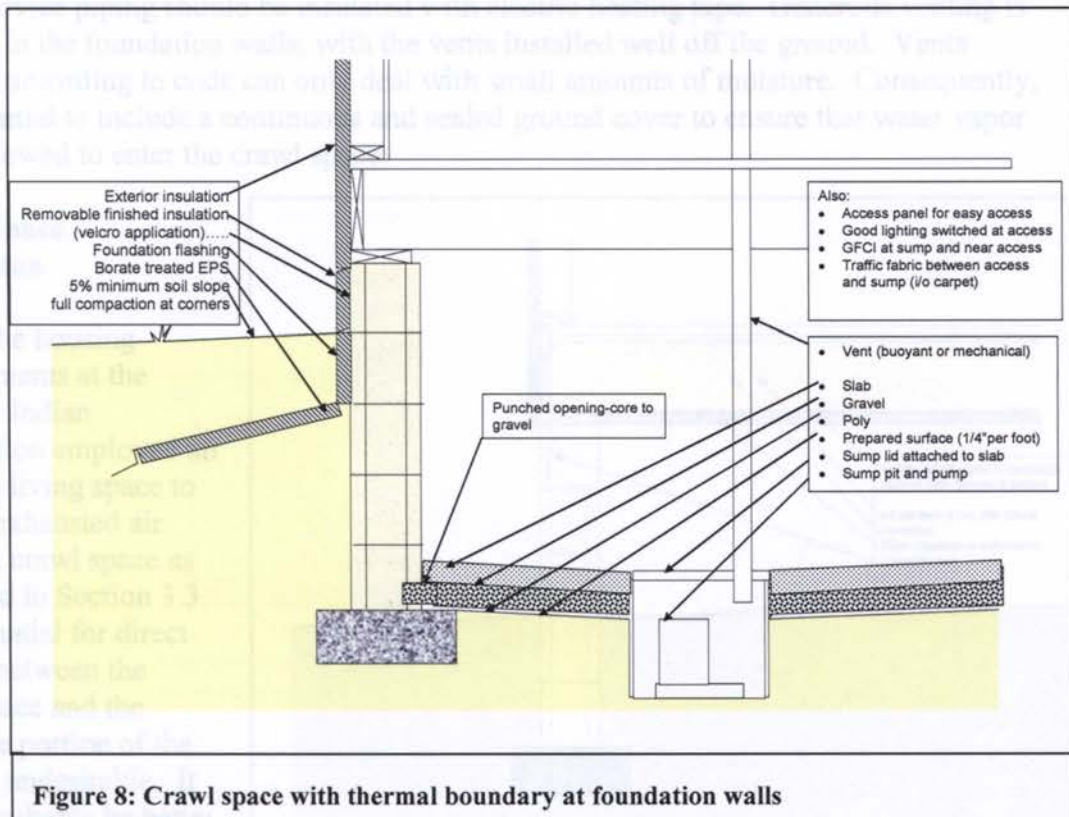
4.2 Crawl Space Design

Moisture entry and evaporation from foundation sources can be major contributors to the moisture load in a home. Rarely inspected, crawl space problems often go unaddressed. When moisture entry is acute, framing and subflooring can deteriorate and support mold. The following points relate to crawl spaces in general, regardless of thermal boundary:

1. Crawl spaces should have easy access and good lighting to facilitate regular inspections. Allow sufficient headroom for reasonable ease of movement and ability to perform repairs and improvements.
2. Control water entry into crawl spaces. Poor rainwater management is the leading source of water in crawl spaces. Other sources include; poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge.

3. Cover crawl spaces with a ground material: a slab of concrete, a polyethylene sheet or other vapor-proof material, sealed to the foundation walls inside the crawl space. Seal all joints and seams also.
4. Insulate crawl spaces. The two ways to insulate a crawl space depend on where the thermal boundary is to be established. The thermal boundary is the building section that separates conditioned space from outside conditions. Insulation can either be placed on the crawl space walls (placing the crawl space inside the thermal boundary) or in the floor of the house (placing the crawl space outside the thermal boundary). If the crawl space contains mechanical systems, such as plumbing or ductwork, the space should be inside the thermal boundary.

The following discussion on new crawl space design is provided to clarify principles, and to serve as a guide for future construction. First a clear distinction should be made whether the crawl space walls or the floor above the crawl space is the thermal boundary for a home. Insulation on the foundation walls indicates that the foundation walls form the thermal boundary (Figure 8) and that the crawl space is part of the conditioned space. In this case, it is not desirable to provide crawl space ventilation, which is analogous to opening a window in a heated room. If insulation is placed in the floor above the crawl space, then the floor is the thermal boundary, and ventilation can be installed. Mechanicals (plumbing, ductwork) should be inside the thermal boundary in all cases.



Crawl Space Walls Are the Thermal Boundary

Figure 8 shows the unvented crawl space and an exterior insulation system that allows a shallower frost wall, although the foundation wall may be insulated down to the footing, either on the inside or outside of the foundation wall. The drawing also shows a concrete pad sloped to a sump pump. Should water get into the crawl space, it can be drained and pumped from the crawl space. The concrete pad serves as a ground cover that can be cleaned and is more durable than a polyethylene ground cover.

The crawl space is designed as a stubby basement that is conditioned as a result of ductwork, or in some cases, furnaces being located there. As unvented crawl spaces are not usually allowed by most codes, it may be necessary to add closeable vents in order to obtain a building permit.

Floor above the Crawl Space is the Thermal Boundary

Figure 9 shows a well-vented crawl space where the subfloor of the home serves as the thermal boundary. The bellyboard membrane seals the home from the crawl space. A small drain to discharge any leaks or overflows from the bathroom and kitchen may be added. No ductwork or piping should be at floor level and run into the crawl space.

Water service piping should be insulated with electric heating tape. Generous venting is required in the foundation walls, with the vents installed well off the ground. Vents installed according to code can only deal with small amounts of moisture. Consequently, it is essential to include a continuous and sealed ground cover to ensure that water vapor is not allowed to enter the crawl space.

Crawl Space Ventilation

One of the housing developments at the Spokane Indian Reservation employed air from the living space to replace exhausted air from the crawl space as described in Section 3.3. The potential for direct contact between the crawl space and the habitable portion of the house is undesirable. It would probably be better if the entire crawl space ventilation system were

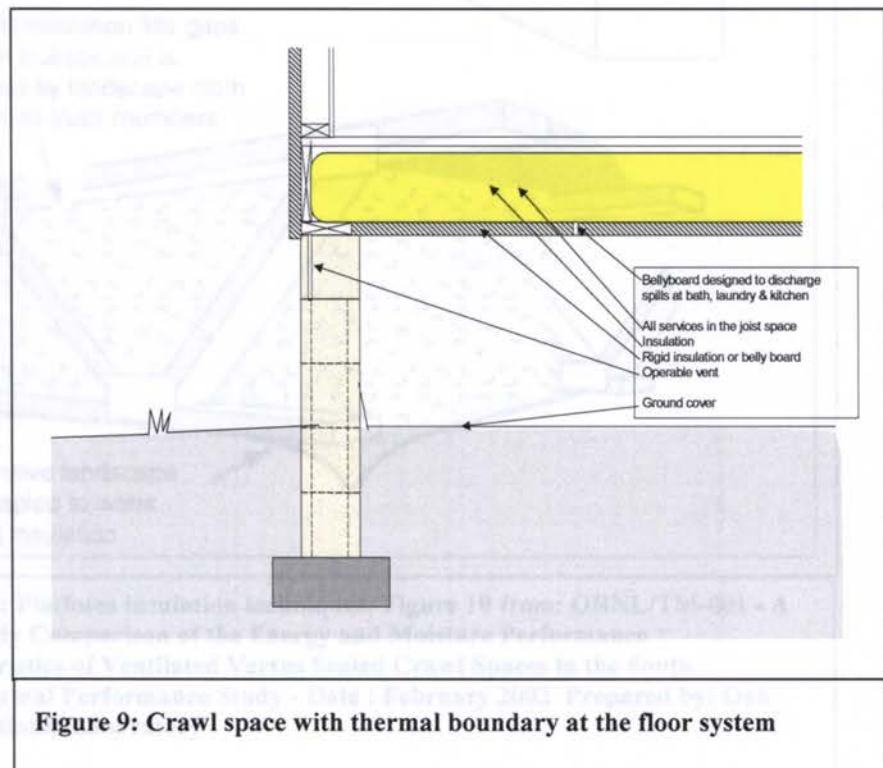


Figure 9: Crawl space with thermal boundary at the floor system

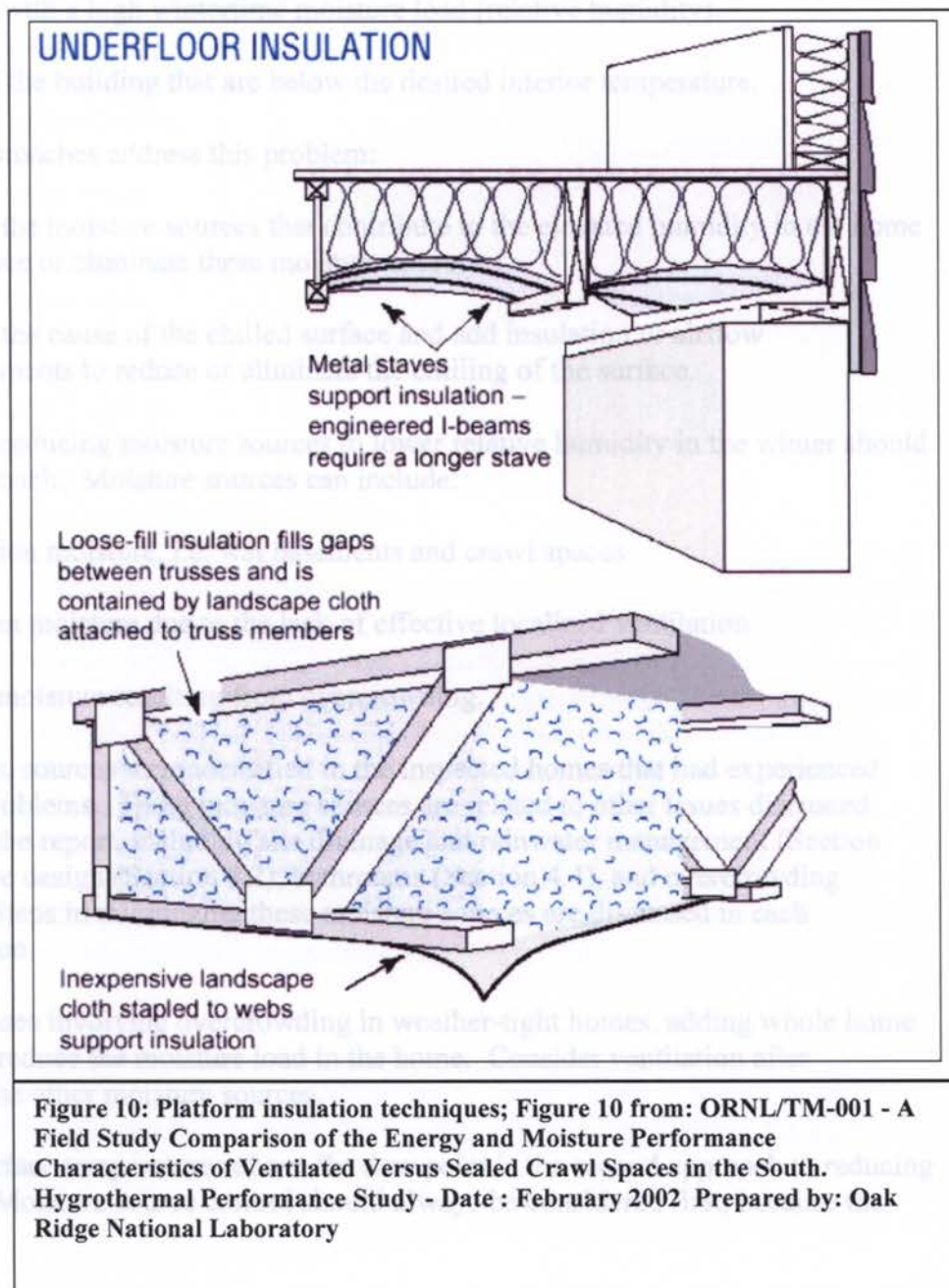
eliminated. Seal the ducts connecting the crawl space to the habitable spaces. Remove the grills and patch the drywall. Leave the rest of the system in place. Disconnect the electricity to the fan and humidistat.

If the crawl space needs vented, retrofit vents through the rim joist and install standard crawl space vents. Seal all penetrations through the floor system, such as at electrical and plumbing penetrations, with either a silicone caulk or spray foam. Test crawl spaces for radon, and if the tests indicate high levels of radon, install a crawl space ventilation system to exhaust the gas.

Insulation Installation

During the debriefing session a discussion regarding insulating foundations arose. Mr. Richard Garry stated in the new housing development the platform was insulated rather than the foundation stem wall. The following illustration (Figure 10) shows two different methods for proper installation of insulation in the platform.

If fiberglass batt insulation is used, install the metal staves low on



the joist so that the insulation does not get compressed against the subfloor.

For additional information on crawl spaces see:

http://www.advancedenergy.org/buildings/knowledge_library/crawl_spaces/

4.3 Winter Condensation Problems

Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point of the air. When this happens, the moisture content of the materials at the location increases, often up to saturation, and mold grows on the surfaces. This problem indicates a combination of two factors:

1. A home with a high wintertime moisture load (relative humidity).
2. Areas of the building that are below the desired interior temperature.

Two typical approaches address this problem:

1. Identify the moisture sources that contribute to the elevated humidity in the home and reduce or eliminate these moisture sources.
2. Identify the cause of the chilled surface and add insulation or airflow improvements to reduce or eliminate the chilling of the surface.

Identifying and reducing moisture sources to lower relative humidity in the winter should be the first approach. Moisture sources can include:

1. Foundation moisture, i.e. wet basements and crawl spaces
2. Bathroom moisture due to the lack of effective localized ventilation
3. Human moisture resulting from overcrowding.

Several moisture sources were identified in the inspected homes that had experienced condensation problems. These moisture sources are related to other issues discussed individually in the report, including site drainage and rainwater management (Section 4.1), crawl space design (Section 4.2), bathrooms (Section 4.4), and overcrowding (Section 4.5). Steps in minimizing these moisture sources are discussed in each respective section.

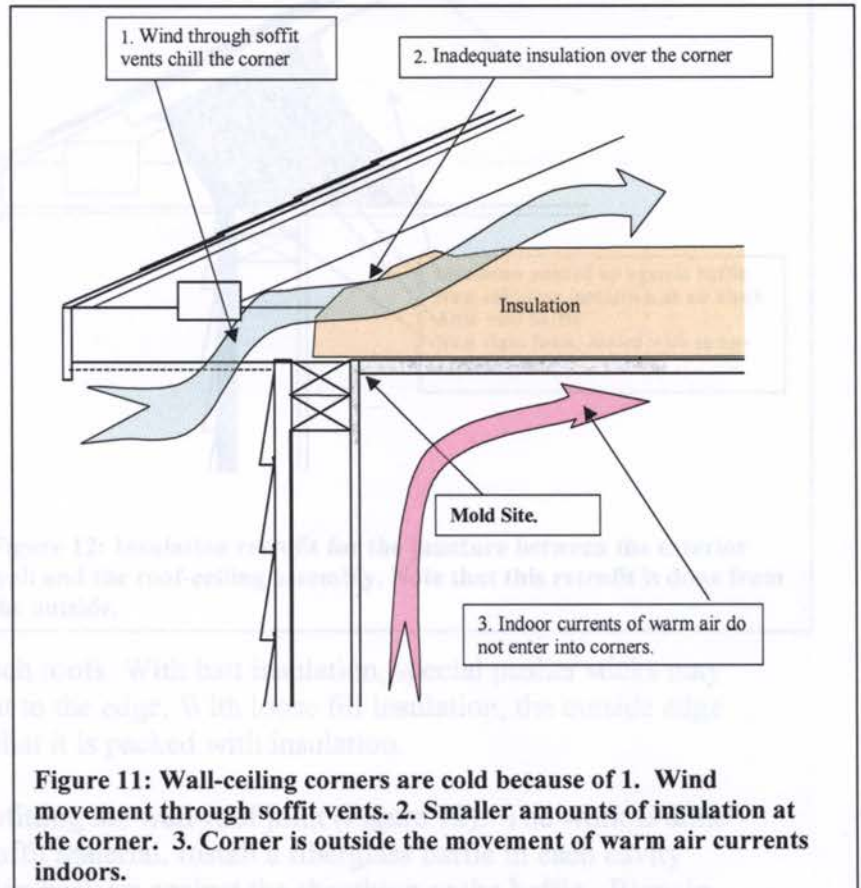
Especially in cases involving overcrowding in weather-tight homes, adding whole home ventilation can reduce the moisture load in the home. Consider ventilation after addressing all the other moisture sources.

Maintaining surface temperatures above the dew point is the second approach to reducing condensation. Moisture source control should always be considered first, because the

lower the relative humidity, the lower the temperature that is tolerable within the home. However, the problem can occur at a reasonable interior humidity if there is a specific construction flaw that allows a surface to get chilled in the winter.

A common condition contributing to winter condensation and mold problems often occurs in closets on an exterior wall. The design and use of closets create this common condition, specifically:

1. Lack of heat supplied to closets.
2. Closed closet doors.
3. Lack of airflow in closets to distribute heat to the exterior surface.
4. Closet clutter which prevents airflow and heat from reaching the exterior closet walls.
5. Clothes hanging against the wall which can act as insulation and lower the temperature of the wall.



Since a relatively cold room contributes to mold growth, ensuring that the exterior wall

of the closet does not get chilled will help prevent this mold growth. Closets should not be cluttered and residents should maintain some distance between the clothes and the exterior wall. Closet doors should be louvered and the room kept at a comfortable temperature. Exterior walls should also be insulated. Again, the moisture load in the house should be kept at a minimum.

The exterior wall/ceiling junctures often experience chilling and subsequent condensation and mold contamination, especially in northern climates in older ranch-style homes with low-pitched roofs.

Three factors leading to cold exterior wall/ceiling juncture include (Figure 11):

1. Cold wind may enter through soffit vents and pass through the porous insulation material, degrading its thermal performance.

2. The insulation may have been poorly installed resulting in reduced amounts of insulation in the corner.
3. The geometry of the corner may prevent slow-moving currents of warm air from reaching into the corners.

Dark spots occur on interior surfaces that are chilled due to poor insulation. In new construction, use a raised-heel truss and carefully insulate the wall-roof joints. It is difficult to adequately insulate the exterior edge of the attic,

especially in homes with low-pitch roofs. With batt insulation, special pusher sticks may be used to push the insulation out to the edge. With loose fill insulation, the outside edge should be prepared correctly so that it is packed with insulation.

In existing homes, consider retrofitting the wall-roof joint (Figure 12). The work is done from the outside. Remove the soffit material. Install a fiberglass baffle in each cavity space. Push the existing insulation back up against the sheathing or the baffle. Blow in new cellulose insulation or pack in fiberglass insulation into the cavity. Then install pre-cut rectangles of rigid foam insulation to block air flow. If blowing in loose-fill insulation, the rigid foam insulation should be installed first, followed by blown insulation. Use a two-part spray polyurethane foam (Figure 13) to keep the rigid rectangle in place. Replace the soffit. If the attic is ventilated, make sure that nothing blocks the baffles. Air seal between the top plate and the insulation baffle. Replace fiberglass insulation.

Spray polyurethane foam has an R-value of 6 per inch. It is also impermeable to air flow. The foam should provide the necessary insulation and air seal to elevate the interior surface temperature of the wall/ceiling juncture.

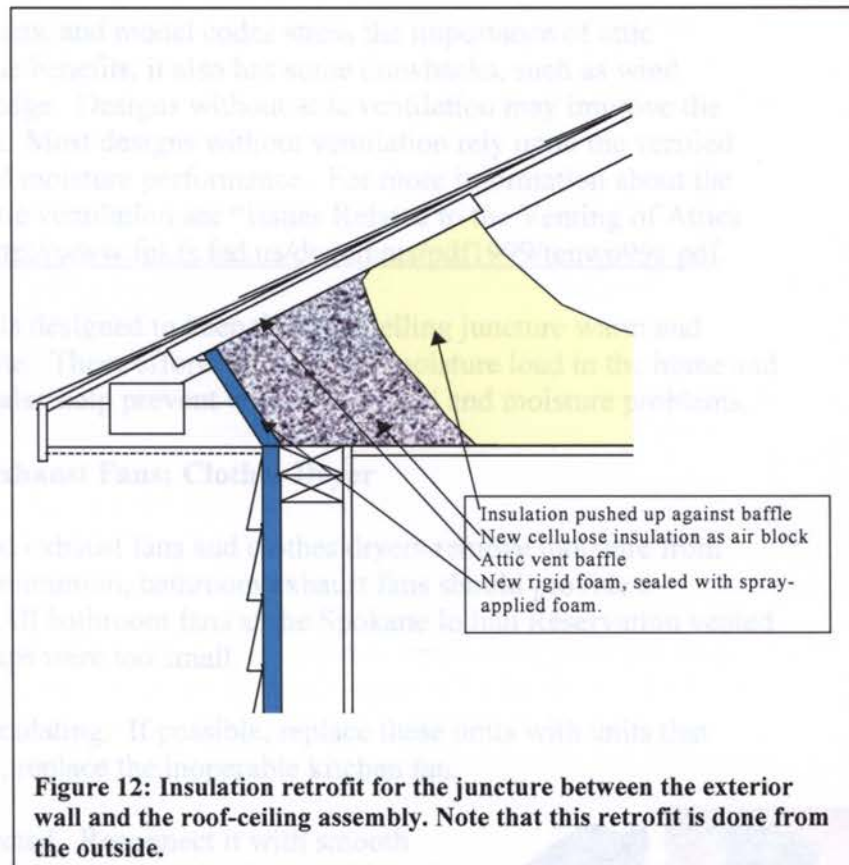


Figure 13 – Two-part spray polyurethane foam

Many individuals, organizations, and model codes stress the importance of attic ventilation. While it has some benefits, it also has some drawbacks, such as wind washing of insulation at the edge. Designs without attic ventilation may improve the performance of the eave area. Most designs without ventilation rely upon the verified airtight ceiling plane for good moisture performance. For more information about the benefits and drawbacks of attic ventilation see "Issues Related to the Venting of Attics and Cathedral Ceilings" at <http://www.fpl.fs.fed.us/documnts/pdf1999/tenwo99a.pdf>.

The retrofit described above is designed to keep the wall/ceiling juncture warm and eliminate the condensation site. These efforts to lower the moisture load in the home and reduce the relative humidity also help prevent wintertime mold and moisture problems.

4.4 Bathroom & Kitchen Exhaust Fans; Clothes Dryer

Properly operating and vented exhaust fans and clothes dryers remove moisture from bathrooms and homes. At a minimum, bathroom exhaust fans should provide a ventilation rate of 70 CFM. All bathroom fans at the Spokane Indian Reservation vented to the outside, but the vent caps were too small.

Two kitchen fans were re-circulating. If possible, replace these units with units that exhaust to the exterior. Also, replace the inoperable kitchen fan.

One dryer vent was disconnected. Reconnect it with smooth metal ducting. Install a dryerbox to help make the transition if the dryer is located in a laundry room (Figure 14). Cost is about \$20 (www.drybox.com).

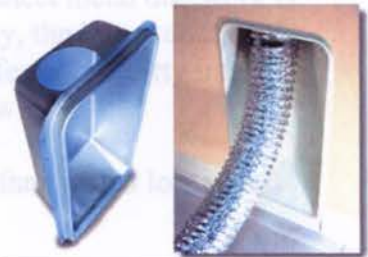


Figure 14 – "Dryerbox"

Many home mold and moisture problems occur in bathrooms due to the presence and use of much water. Keeping bathrooms dry involves care in several areas:

1. Bathroom plumbing should not leak in either the water supply system or the drain-waste-vent (DWV) system. Promptly fix all plumbing leaks. Some hard to detect leaks at the toilet flange or shower drain require careful inspection.
2. Use shower curtains so that shower water does not splash outside the tub. Toilet wetting on the areas around the toilet should be minimized. Surfaces in the bathroom should be selected and installed to keep water away from drywall and other materials that may permit mold to grow. Wipe up spills promptly and clean dirty and discolored spots. Correct the water problems that may have led to the spotting. Damaged drywall should be removed and replaced. Keeping surfaces clean and dry is primarily the responsibility of the residents of the home.
3. Bathrooms, kitchens and laundry rooms frequently have high humidity from cooking and cleaning, clothes dryers, bathing, and showering. Properly installed

and vented exhaust fans serves as a source control strategy for reducing the moisture load in a home. Exhaust ventilation dilutes the moisture and places the room in a negative pressure, thus limiting the spread of moisture to the rest of the home until most of the moisture has been removed to the outside.

4. Vent bathroom and kitchen exhaust fans, as well as clothes dryers to the outside rather than into the living space. Venting to the basement, crawl space or attic can lead not only to moisture problems occurring in these areas, but also throughout the house. For this reason, localized exhaust ventilation requires ductwork to reach the outside. If the vent discharges through the roof, make sure the vent has an effective check valve to prevent wind from blowing back through the vent. Also, insulate ductwork that passes through an unconditioned space.
5. Size bathroom exhaust fans for the volume of air exhausted and at a minimum of 70 cubic feet per minute (CFM). The effectiveness of exhaust fans depends on the power of the exhaust fan, length and type of exhaust duct and cleanliness of the fan grille. When there is excessive resistance in the ductwork, the exhaust fan motor may not be powerful enough to vent sufficient airflow through the duct. The longer the duct length, the greater the static pressure in the duct and the less air flow through the duct. Turns and bends in the ductwork also increase the static pressure and reduce flow. Similarly, a smooth duct provides less resistance and improved flow than ribbed ductwork. Round, smooth sheet metal ductwork is recommended for all types of exhaust ventilation. Generally, the larger duct, with the fewest bends or elbows, and the shortest duct run is preferred. A dirty intake grille will also greatly increase resistance and reduce airflow.
6. Occupants do not use noisy exhaust fans, so select exhaust fans with a low sone rating. To ensure their use, consider:
 - Exhaust fan hard-wired to the bathroom light.
 - Exhaust fan on a timer, to extend moisture dilution time after showering.

A good system includes both of these features. The fan is hard-wired to the light, but also runs for a programmed period following bathroom use. The fan is programmed to operate for an extended period of time, from 1 to 60 minutes. Fan delay timers are about \$40. (This set up is available from Energy Federation Incorporated, www.efi.org, Fan/Light Time Delay Switch). Educate and encourage residents to always use the bathroom exhaust vent.

7. Inspect all bathroom and kitchen fan ducts to ensure they are properly attached and sealed to the exhaust fan housing and terminated outside the home not below the roof vents.
8. If exhaust venting is taken through the roof eaves, ensure the ducts terminate and are sealed to properly designed eave vent for exhaust fan termination.

9. Insulate bath and dryer ducts located in attics to prevent warm moist air condensing in the duct and possibly running back to the inside.

4.5 Insulate & Air Seal Attic Hatches

A non-air sealed attic hatch is a type of bypass or alternate space through which air can pass (Figure 15). Mold can condense on access hatch blocking if not air-sealed. Air-seal the hatches with weather stripping or gaskets. Install latches to lock the hatches in place and provide positive closure.

Insulate attic hatches to a minimum of R38 but no less than R19. A lightweight attic hatch may be cut from damaged insulated foam core doors. The door has an R-value around 7. Batt or rigid insulation may be attached to the back of the door panel to achieve the desired R-value. The door panel is pre-finished, lightweight and requires no additional painting.

4.6 Human Moisture Sources

Human occupation also produces moisture in buildings. Humans are similar to internal combustion engines, and respiration, the act of breathing, produces considerable moisture. Other human activities and preferences which also produce moisture include:

- Showering
- Cooking
- Cleaning
- Drying laundry indoors
- Accidental spills
- House plants
- Firewood storage
- The use of humidifiers and vaporizers

All these moisture-producing activities contribute to the moisture load in a home.

However, human moisture sources alone do not produce enough moisture to cause winter condensation and mold problems in the winter. Two circumstances under which human moisture sources may create mold problems include:

1. Overcrowding. When the number of residents living in a home exceeds the expected capacity of the home, the moisture burden increases. Each person participates in moisture-producing activities (breathing, cooking, washing, etc.) increasing the total moisture load.

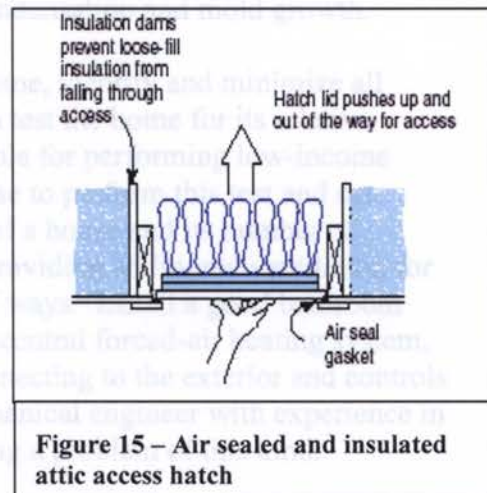


Figure 15 – Air sealed and insulated attic access hatch

2. Weather-tight construction. In the absence of a mechanical ventilation system, natural infiltration (air leakage) provides fresh air in homes during the winter. This fresh, dry, winter air dilutes the moisture in the interior air and helps keep relative humidity under control. The amount of infiltration (the air change rate) that occurs in a house varies with the house. Some houses are naturally leaky, especially older homes, while others are more airtight. A particularly tight home may exhibit high relative humidity in the winter, which can lead to moisture and mold problems.

When a home is both overcrowded and has a low air change rate, an excessive moisture load can occur increasing the potential for localized condensation and mold growth.

If winter condensation problems occur in a crowded home, identify and minimize all other sources of moisture. If the problems persist, then test the home for its relative tightness, using a blower door test. Agencies responsible for performing low-income weatherization usually have the equipment and expertise to perform this test and can confirm whether the air change is too low for the size of a house and its number of residents. If this proves to be the case, then consider providing additional ventilation for the home. This can be accomplished in any number of ways. Install a good bathroom exhaust fan on a humidistat control. If the home has a central forced-air heating system, augment the existing fan and ductwork with a duct connecting to the exterior and controls to provide fresh air circulation. The services of a mechanical engineer with experience in residential ventilation systems can help when addressing a problem of this kind.

4.7 Heating Systems and Moisture Control

In winter, heating systems provide occupant comfort. Heating systems also impact winter moisture problems in several ways. Two critical points include:

1. The heating system is a major determinant of the temperature of interior surfaces. Inadequate or poorly distributed heat can chill some wall and ceiling surfaces near or below the dew point temperature. This leads to condensation problems. Occupants exacerbate this if they close off rooms, cover supply ducts, block airflow to exterior walls, or set the thermostat too low.
2. With the exception of electric heat, most heating systems depend on the combustion of fuels with a major byproduct, water vapor. If a combustion appliance is improperly vented, or not vented at all, the heating system can contribute significant amounts of moisture into the interior air.

With regard to the first issue, central heating systems are preferred over stationary, single source heating systems, such as propane space heaters and wood stoves. Central heating systems feature ductwork that supplies heated air (or heated water to radiators in hydronic systems) to all the major living spaces of the house. A properly designed and functioning heating plant and distribution system keeps all the rooms warm. This

minimizes the potential for chilled surfaces, which become potential condensation and mold contamination sites.

Economic reasons sometimes cause residents to limit the heating of spaces such as bedrooms. Although understandable, this practice can contribute to chilled exterior surfaces and result in condensation and mold growth.

With regard to the second issue, any appliance that burns a fuel, such as gas, fuel oil, or wood, produces moisture. Generally, for every molecule of fuel consumed, two molecules of water vapor are produced. If the combustion gases are not well ventilated to the outside of a home, the appliance can contribute large quantities of moisture into the indoor air. The excessive moisture load in the air can be a major contributor to winter moisture problems in the home.

Electric baseboard and in wall heaters were at several homes. Using electric point source heat as the primary heating source, with only its low first-cost as an advantage, is not advisable. Unless the Reservation has negotiated a very low electric rate with the local utility, electric heat is expensive to operate. It also does not promote air circulation like a forced air unit. Poor air circulation could contribute to future mold problems. Heating method and heat distribution play a vital role in preventing wintertime mold and moisture problems.

4.8 Maintenance Issues

Many moisture problems and consequent mold contamination result from deferred maintenance. If water infiltration problems from plumbing, roofing, or foundation sources linger, a small problem can turn into a large problem, if not repaired quickly. Unfortunately, water leaks often go unreported and unattended.

SIHA maintenance department is the best defense against mold and moisture complaints. A proactive maintenance program guards against mold and moisture problems by including the following procedures:

1. Perform regular inspections of properties to identify problematic moisture conditions.
2. Encourage residents to report moisture problems.
3. Respond promptly to identified and reported moisture problems to prevent excessive mold contamination.

Clearly, a prompt response implies a partnership between tenants and SIHA. Occupants must promptly report mold and moisture problems, and maintenance staff must promptly respond to those reports. If either party delays, the list of deferred maintenance items grows, and small moisture and mold problems become major problems with possibly

severe mold contamination. Train maintenance staff in the following items to assist in solving and eliminating moisture and mold problems:

General

- What is mold
- What causes mold
- Other Indoor Air Quality (IAQ) problems
- Sources of moisture
- Moisture assessment procedures

Exterior

- Site drainage
- Maintenance of roof drainage systems (gutters, downspouts, etc.)
- Paving adjacent to homes
- Repair of roofs and roof flashings

Foundations

- Crawl space design issues
- Sump pump system desired, installation, and disposal of water

Attics

- Attic bypasses
- Attic hatches
- Attic ventilation
- Insulation
- Wall/ceiling junctures

Mechanical

- Bathroom and kitchen exhaust fans
- Venting exhaust fans to the exterior
- Plumbing leaks
- Humidifiers
- Unvented appliances

Mold Remediation

- Clean-up
- When to call for outside help

At the same time, occupants should be aware of their crucial role in preventing mold and moisture problems. Many occupant issues bear directly on the causes and severity of moisture and mold problems. Occupants should receive training on the following topics to assist in solving and eliminating moisture and mold problems in their homes.

- What is mold and what causes it
- Use of exhaust fans
- Regular bathroom cleaning
- Avoidance of clutter in critical locations (exterior walls of closets, etc.)
- General housekeeping

- Use of crawl spaces
- Gutter and downspout maintenance
- Difference between plumbing leaks and water condensation on pipes
- Use of sump pumps
- Humidifiers and dehumidifiers

4.9 Remodel & New Construction Recommendations

The following are some recommendations for rehabilitation and new construction projects for the SIHA.

On the Exterior of the Home

1. Keeping soil dry next to a foundation is the preferred approach for maintaining a dry basement or crawl spaces. However, there are occasions when this may not be possible. A good second line of defense is to use a high quality waterproofing membrane on the exterior face of the foundation wall. There are many trowel or spray applied products on the market. Once applied, these products create a monolithic and highly flexible membrane with crack-bridging properties (e.g. - www.appliedtechnologies.com or www.carlisle-ccw.com). These membranes should be protected with either a geotextile covering (e.g. <http://www.deltams.com/deltadrain/>) or rigid insulation (e.g. DOW Styrofoam Perimate) before backfilling.

In addition to carefully waterproofing foundation walls, drain tiles installed at the base of the foundation dispose of water that drains down the face of the wall. Usually this tile is connected to the sump pit, or if possible, is run to daylight.

Properly sealing and draining crawl spaces or basement foundation walls is as important as properly installing shingles on a roof. Unfortunately, foundation walls are frequently not provided the same attention as roofs. Roofs are visible and everyone understands that a leaky roof will result in a host of problems. On the other hand, foundations are below grade and not visible, and thus do not appear to be as important as roofs. However, this belief is incorrect. It does not matter whether moisture comes from above or below. All unwanted moisture should be kept outside the building structure. Although foundation leakage may not result in obvious water spots on the ceiling such as from a roof leak, water from a foundation leak can cause structural damage, contribute to mold growth, and compromise habitable spaces. The importance of properly sealing and draining foundations cannot be overemphasized.

2. Criteria to consider when selecting the siding for a structure include: performance (maintainability, durability, repairability, permeability, etc.), aesthetics, first-cost, and life-cycle-cost. Frequently, the selection of siding is based on lowest first-cost. SIHA should carefully scrutinize all siding options and not base its selection solely on first-cost. Durability of siding should be an important factor in the

selection process. Investing a little more initially can result in significant overall savings. Conduct a life-cycle-cost analysis to justify the selection process. Consider high quality, heavy gauge, insulated vinyl siding, or fiber cement composite siding (<http://www.jameshardie.com/>), are some of the siding options.

On the Interior of the Home:

1. One common problem the assessment team identified was mold and deterioration of drywall behind toilet tanks. Condensation on the outer surface of the toilet tank wet the adjacent wall area often. Since the wet wall behind the toilet tank was difficult to clean, mold grew, and the wall deteriorated.

Two ways to mitigate this problem include:

- a. Install a toilet with an insulated tank. This results in a higher toilet tank surface temperature, thus less surface condensation.
 - b. Supply both hot and cold water to the toilet through a mixing valve. The increased water temperature inside the tank will result in less surface condensation. Only a small amount of hot water is introduced, thereby keeping the reoccurring cost low. The supply of hot and cold water through a mixing valve has been implemented at other Indian housing communities with positive results.
2. The temperature of water supplied to Indian housing in the northern tier of the United States is very cold. Many inspected homes had hot and cold water supply piping in the basement or crawl spaces that were dripping water due to surface condensation. This condensation can contribute a significant amount of water to the interior moisture load. Insulate all hot and cold water supply piping, the hot water lines for energy conservation and the cold water lines to eliminate condensation.
 3. Cleanup of mold at the wall to ceiling junction is very difficult, if not impossible, if the ceiling has a rough textured finish. It is highly recommended that ceilings be finished with a smooth or a skip-trowel finish in lieu of a rough popcorn finish.
 4. One by-product of high-efficiency furnaces is water. During winter months, when the furnace is running frequently, these units produce a significant amount of water. This water should be either drained directly to the exterior, into a condensate pump which then pumps the water to a drain or exterior, or into the sump pit from where it can then be pumped to the exterior.

1	2	4	5	6	7	8		10	11	12	13	14	15	16	17	18	19
Inspection Number	Address	Building Age	Occupancy	Foundation Type	Model and Framing Type	Primary Heat Type	Secondary Heat Type	Site Drainage Problems	Gutter System Problems	Leaks from Exterior	Wet Basement or Crawl Space	Plumbing Problems	Bathroom Problems	Exhaust Ventilation	Exterior wall/ceiling problems	Attic Problems	Visible Mold (Column #)
1-1	6365 Sherwood Loop Rd	25	10	Concrete	Split Level 2x6	Pellet Stove	Electric In-Wall Heaters	No	No	No	Did Not View	No	Yes		No	Yes	15, 18
1-2	6452 Mathew Cutoff Rd.	18	3	Concrete	Ranch 2X6	Wood Stove	Electric In-Wall Heaters Never Used	No	No	No	No	No	Yes		No	Yes	15, 18
1-3	6513 Nancy Flett Rd.	18	3	Concrete	Ranch 2X6	Wood Stove	Electric In-Wall Heaters Never Used	No	No	No	Did Not View	No	Yes		No	Yes	15, 18
1-4	6198A Sherwood Loop Rd.	15	4	Concrete	Ranch 2X6	Pellet Stove	Electric In-Wall Heaters (Interior Walls) Never Used	No	No	No	No	No	Yes		Yes	Yes	13, 15, 17, 18
1-5	6370 Lookout site Rd. #65	21	3	Concrete	Ranch 2X6	Wood Stove	Electric In-Wall Heaters (Exterior Walls) Never Used	Yes	No	Yes	Yes	No	Yes		No	Yes	15, 18
1-6	5570 Sadie St.	25	3	Concrete	Ranch 2X6	Wood Stove	Electric In-Wall Heaters (Exterior Walls)	No	Yes	Yes	No	Yes	Yes		Yes	No	13, 15, 17
1-7	5597 Albert Sam Avenue	22	1	Concrete	Split Level 2x6	Wood Stove	Electric In-Wall Heaters (Interior Walls)	Yes	No	No	No	No	Yes		Yes	Did Not View	13, 15, 17
2-1	6441 Molly Court	24	4	Concrete	Ranch 2X6	Electric In-Wall (Outside Walls)	None	Yes	No	No	No	No	No		No	Yes	18
2-2	6440 Molly Court	24	3	Concrete	Ranch 2X6	Wood Stove	Electric In-Wall Heaters (Interior Walls)	Yes	Yes	No	No	No	Yes		No	No	13, 15
2-3	6444 Selena Court	21	4	Concrete	Ranch 2X6	Electric In-Wall (Outside Walls)	Wood Stove Never Used	Yes	Yes	No	Yes	Yes	Yes		No	No	15

I = mutual help

LR = Low Rent

Inspection Number: 1-1

Address: 6365 Sherwood Loop Rd.

Model Type: Split-Level

Foundation: Concrete basement and crawl space

Construction: 2 x 6 Wood Frame

Heat Type: Pellet Stove (Primary) and Electric In-Wall Heaters

Bedrooms: 4

Occupancy: 6 Adults and 4 Children

Age: 25 Years

Mold and Moisture

Conditions: Mold was present in the bathroom (Figure 2 & 3), in the attic (Figure 3) and on the basement windows.

Site Drainage and Rainwater

Management: The site drained away from the home.



Figure 2: Mold at tub to surround junction



Figure 1: Front elevation



Figure 3: Mold at wall to ceiling junction above bathtub

Foundation Conditions: The home rested on a concrete foundation.

Crawl Space and Basement Conditions: The crawl space was reported to be dry and to have a vapor barrier. There were two bedrooms and a laundry/utility room in the lower level. One bedroom window was reported to have mold and a heavy blanket covering. The crawl space and basement were not viewed.

Exterior Conditions: Metal roof and wood siding were in good condition. No gutters were present.

Bathroom: The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, exhausted with low efficacy to the outside. The tub/floor caulk seal was compromised and mold compromised the drywall above the tub/shower (Figure 2).



Figure 4: Mold on roof sheathing



Figure 5: Possible leaky bath fan duct

Kitchen: The electric stove had a re-circulating range hood.

Interior Conditions: The interior of the unit was in good condition.

Attic: The attic section above the bathroom needed more insulation. It appeared that someone had been working in the attic, moved the insulation off to the sides, and had not replaced it. The attic hatch was not insulated. The remainder of the attic had approximately ten inches of insulation. Mold was visible on the roof sheathing, particularly above the area where the bath fan vented to the exterior (Figure 4), and a (former) bird's nest was present.

Occupant Notes: Six adults and four children lived in the home; several were scheduled to relocate soon. Two children suffered from asthma. Four occupants (adults and children) suffered from allergies. One occupant smoked, but not in the home.

Discussion/Recommendations:

On the Exterior:

1. The exterior of the home was very well maintained. Refill and reseed light depressions around the perimeter of the foundation, but other than that, the home was in wonderful condition.

On the Interior:

1. The mold on the ceiling above the tub should first be scrubbed with soap and water to see if it can be removed. If the mold has compromised the paper face of the drywall, the drywall will need to be removed.
2. Remove the insulation baffles between the trusses above the bath area. Seal this area so that exterior air entering through the soffit can not wash through the insulation. Place plenty of insulation above the top plates in this area.
3. Replace the bathroom fan with a high quality unit that exhausts at least 70 CFM (preferably more) and is vented to the exterior. Cover everything with insulation after the bathroom fan and duct work is installed. Insulate the ductwork to avoid condensation inside the duct.
4. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
5. When not in use, keep the bath door open so that heat rising up the staircase can warm this room, or use the electric heater to keep the room warm. Keeping the room warmer will help mitigate mold problems.

6. The mold on the roof sheathing is particularly concentrated directly above the area where the bath vent exhausts through the gable-end wall (Figure 4). This could possibly indicate a leak in the bath ductwork near this location. The transition of the bath duct from flex-duct to rigid appeared suspect (Figure 5). This may be the source of moisture.
7. In the attic, check attic screens and remove bird's nest.
8. Insulate and weather-strip the attic hatch.
9. Upon close examination of the photos, it appears that there is a problem with the eschusion plate behind the bath control knob (Figure 6). The eschusion plate appears to have slid down and also appears broken towards its center. This should be checked. If it is broken, water may be leaking into the wall at this location. Replace if damaged.
10. Thoroughly clean, dry and seal with a high-quality, mold resistant caulk the junction between the tub and the surround.
11. In the basement, clean mold from the window. Draw the blanket back during daytime hours to allow air to circulate over glass.
12. Install a range hood that is vented to the exterior.



Figure 6: Damaged eschusion plate?



Figure 4: Crawl space vent directly next to plywood soffits

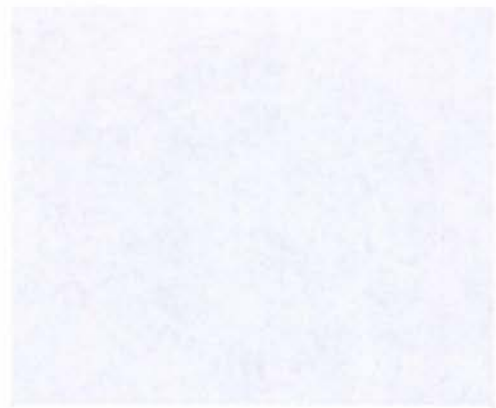


Figure 5: Clogged bath room fan grill

Inspection Number: 1-2

Address: 6452 Mathew Cutoff Rd.

Model Type: Ranch

Foundation: Concrete crawl space

Construction: 2 x 6 Wood Frame

Heat Type: Wood Stove (Primary) and
Electric In-Wall Heaters (Not
Used)

Bedrooms: 3

Occupancy: 2 Adults and 1 Child

Age: 18 Years

Mold and Moisture Conditions: Mold was on all the bathroom windows and in the attic (Figure 2).

Site Drainage and Rainwater Management: The site, somewhat flat, drained away from the home.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space was dry, clutter free and had a well-installed vapor barrier. Insulation was installed on the perimeter stem walls and along the band joist. Sections of insulation along the band joist were missing (Figure 3). The crawl space vents were installed through the band joist (Figure 4).

Exterior Conditions: The metal roof and wood siding were in good condition. The dryer vent cover on the exterior of the home was missing; and a plastic lid was held against the vent opening by an unused appliance.

Bathroom: The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, exhausted with very low efficacy to the outside. The bathroom grill was clogged (Figure 5). There was extensive mold on the bathroom ceiling, particularly along the exterior wall



Figure 1: Front elevation



Figure 1: Mold at wall to ceiling junction in bathroom



Figure 3: Missing rim joist insulation



Figure 4: Crawl space vent directly next to plywood subfloor



Figure 5: Clogged bathroom fan grill

to ceiling junction. A replacement vinyl window was in good condition.

Kitchen: The electric stove had a range hood exhausting to the exterior.

Interior Conditions: The interior of the unit was in good condition. Some mold was present on all windows.

Attic: The attic hatch was insulated. The attic had ten to twelve inches of insulation. Mold was visible on the roof sheathing above the bathroom exhaust fan.

Occupant Notes: Two adults and one child lived in the home. The child suffers from allergies. One occupant smokes in the home.

Discussion/Recommendations:

On the Exterior:

1. Repair the dryer vent so that the dryer can be properly vented to the exterior.

On the Interior:

1. The mold on the bathroom ceiling and walls should first be scrubbed with soap and water to see if it can be removed. If the mold has compromised the paper face of the drywall, the drywall will need to be removed.
2. Remove the insulation baffles between the trusses above the bath area. Seal this area so that exterior air entering through the soffit can not wash through the insulation. Place plenty of insulation above the top plates in this area.
3. Replace the bathroom fan with a high quality unit that exhausts at least 70 CFM (preferably more) and is vented to the exterior. Make sure everything is covered with insulation after the bath fan and duct work is installed. The ductwork should be insulated also to avoid condensation inside the duct.
4. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
5. Currently the bath fan duct exhausts through a small soffit vent. The vent is far too small and constricts the flow of air (Figure 6). A properly sized roof cap, wall cap, or soffit vent should be installed. The cap should have a back-draft damper to keep cold air from blowing into the duct. The duct should be insulated to keep warm moist air from condensing inside the duct

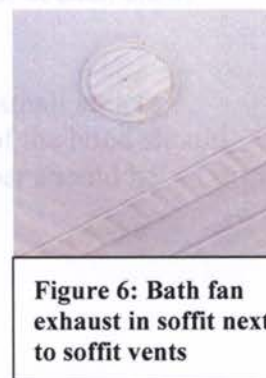


Figure 6: Bath fan exhaust in soffit next to soffit vents

6. Inform the homeowner that the bath fan grill should occasionally be vacuumed to keep the air intake holes free of lint and dust.
7. When not in use, keep the bath door open so that heat and air can migrate into the room, or use the electric heater to keep the room warm. Keeping the room warmer will help mitigate mold problems.
8. Clean mold from windows and draw window coverings back during daytime hours to allow air to circulate over glass.
9. Replace missing insulation sections in crawl space.
10. Install a minimum of 1" thick rigid insulation tight to the subfloor at each crawl space vent extending approximately 2' beyond the rim joist.
11. The venting of the range hood is suspect. There appears to be a small area of mold on the roof sheathing above the range hood. The ducting of the hood should be inspected and an appropriate soffit vent with back-draft damper should be installed.

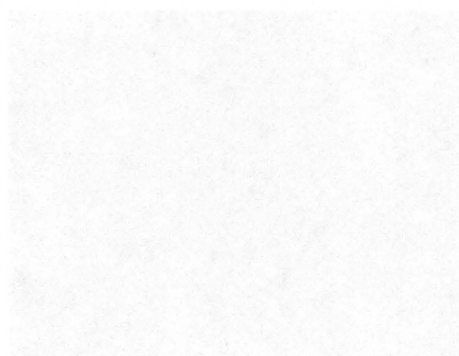


Figure 2: Mold on roof sheathing above the range hood.



Figure 4: Missing insulation in the bathroom crawl space.



Figure 5: Bath exhaust fan in soffit.

Inspection Number: 1-3

Address: 6513 Nancy Flett Rd.

Model Type: Ranch

Foundation: Concrete crawl space

Construction: 2 x 6 Wood Frame

Heat Type: Wood Stove (Primary) and Electric
In-Wall Heaters (Not Used)

Bedrooms: 3

Occupancy: 2 Adults and 1 Child

Age: 18 Years



Figure 1: Front elevation

Mold and Moisture Conditions: Mold was present in the bathroom (Figure 2), in the attic (Figure 3), and on the bedroom windows (Figure 4).

Site Drainage and Rainwater Management: The site drained away from the home.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space was not inspected.

Exterior Conditions: The metal roof and wood siding was in good condition.

Bathroom: The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, was not being used; it vibrated excessively and quickly burned out light bulbs. It exhausted with low efficacy to an undersized round vent in the soffit (Figure 5). Mold compromised most of the ceiling and extended down the walls to the tub surround.



Figure 2: Mold on walls and ceiling in bathroom



Figure 3: Discolored roof sheathing

Kitchen: The electric stove had a range hood exhausting to the exterior.

Interior Conditions: The interior was in good condition. Mold was present on the bedroom window sills, but condensation was not reported. The bedroom was on the colder side of the home. Three fish tanks were present in the



Figure 4: Dirt and mold on the bedroom window sill



Figure 5: Bath exhaust vent in soffit

living room.

Attic: The attic hatch was insulated with ten to twelve inches of insulation. Mold was visible on the roof sheathing above the bathroom.

Occupant Notes: Two adults and one child lived in the home. The child suffered from bronchitis issues when younger. There were no smokers in the home.

Discussion/Recommendations:

On the Exterior:

1. Replace the undersized bath soffit vent with an appropriate roof, wall or soffit vent that has a back-draft damper.

On the Interior:

1. The mold on the popcorn bathroom ceilings and walls is a perfect example of why not to use a rough textured finish. Once mold grows on a textured finish it embeds itself in the cracks and crevices and it is nearly impossible to get rid of.
2. The mold in the bathroom appears to be beyond simple cleaning. The drywall will need to be removed to properly repair this area.
3. Poor heat distribution, a poorly functioning exhaust fan, and an undersized exhaust cap in the soffit all contributed to this problem. None of these were a fault of the homeowner.
4. After removing the loose-fill insulation in the attic above the bathroom, remove the drywall and the insulation baffles between the trusses above the bath area. Seal the area between the exterior face of the top plates and the roof sheathing with rigid insulation so that exterior air entering through the soffit can not wash through the insulation. Either place fiberglass batt insulation prior to the installation of drywall or loose fill insulation after the drywall is installed. Make sure there is plenty of insulation above the top plates in this area.
5. Replace the bathroom fan with a high quality unit that exhausts at least 70 CFM (preferably more) and is vented to the exterior. Make sure everything is covered with insulation after the bath fan and duct work is installed. The ductwork should also be insulated to avoid condensation inside the duct.
6. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
7. Inform the homeowner that the bath fan grill should occasionally be vacuumed to keep the air intake holes free of lint and dust.

8. When not in use, keep the bath door open so that heat and air can migrate into the room, or use the electric heater to keep the room warm. Keeping the room warmer will help mitigate mold problems.
9. Clean mold from windows sills and draw window coverings back during daytime hours to allow air to circulate over glass.
10. Use electric in-wall heaters in bedrooms to increase wall surface temperatures, or use a dehumidifier to lower the humidity in these rooms.
11. Some of the moisture problems in this home are due to the presence of three fish tanks. Water evaporating from the tanks contributes to elevated interior humidity levels.



Figure 2: Hall ceiling and walls constructed by mold.

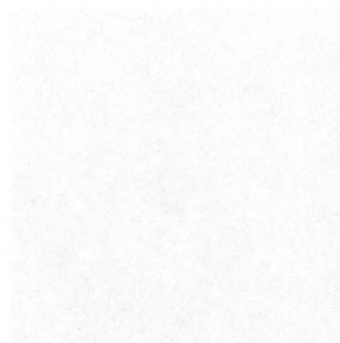


Figure 3: Mold at base of wall in bedroom exterior space.

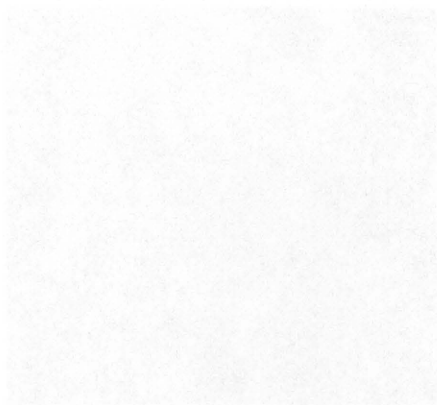


Figure 4: Mold on shower wall.

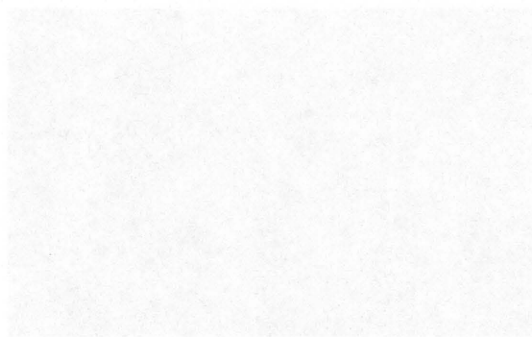


Figure 5: Evidence of water migration from bathroom above into the crawl space.

Inspection Number: 1-4
Address: 6198A Sherwood Loop Rd.
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Pellet Stove (Primary) and Electric In-Wall Heaters (Not Used) on Interior Walls
Bedrooms: 3
Occupancy: 2 Adults and 2 Children (Regular Visitors: 5 Grandchildren)
Age: 15 Years

Mold and Moisture Conditions: Extensive mold was on the bathroom walls and ceiling (Figure 2), in corners in bedrooms (Figure 3), on closet walls (Figure 4), the crawl space (Figure 5), on windows, and on the roof sheathing.

Site Drainage and Rainwater Management: The site, although relatively flat, drained away from the home.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space was dry, and the vents were closed, however there was evidence of former flooding. The walls were insulated, and a vapor barrier was installed. Below the bathroom was evidence of water from above (Figure 5).



Figure 1: Side and front elevation



Figure 2: Bath ceiling and walls consumed by mold



Figure 3: Mold at base of wall in bedroom exterior corner



Figure 4: Mold on closet wall



Figure 5: Evidence of water migration from bathroom above into the crawl space

The dryer vent was disconnected and had been venting to the crawl space for an extended period of time as evidenced by the substantial amount of lint in the crawl space (Figure 6). Clutter was present. Snowmelt had flooded the crawl space 3 to 4 years ago.

Exterior Conditions: The metal roof and wood siding were in good condition. No gutters were present. A trim strip that sealed the junction between the window frame and the surrounding trim boards was missing or loose on several windows (Figure 7). The siding and corner boards were separating and the finish on the siding was worn off in several areas. A hole was reported in the roof. Damage was not yet through the boards. One of the windows was broken (Figure 8).

Bathroom: The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, exhausted with very low efficacy to an undersized round vent in the soffit. Mold was present throughout the bathroom. The owner reported condensation on the toilet tank.

Kitchen: The electric stove had a range hood exhausting to the exterior that did not work.

Interior Conditions: The interior of the unit was in good condition. Mold was present on all windows; condensation was not reported. Mold at thermal bridges was present in all rooms.

Attic: The attic hatch was insulated. The remainder of the attic had ten inches of insulation, which was disturbed in several areas including over the bathroom. Minor mold was present on the roof sheathing.

Occupant Notes: Two adults and two children lived in the home. One adult and two children suffered from asthma. One child was outgrowing the nebulizer, the other was not. There were no smokers in the home.

Discussion/Recommendations:

On the Exterior:

1. Replace the broken window and replace compromised window trim.
2. Refinishing and resealing siding



Figure 8: Broken window and dirt on window sill



Figure 6: Evidence of plumbing leaks and disconnected dryer vent in background



Figure 7: Loose and missing trim strips around window frame

to the corner-boards will extend the life of the siding.

On the Interior:

1. The mold in the bathroom appeared beyond simple cleaning. Remove the drywall to properly repair this area.
2. Poor heat distribution, a poorly functioning exhaust fan, and an undersized exhaust cap in the soffit have all contributed to this problem. None of these are a fault of the homeowner.
3. After removing the loose-fill insulation in the attic above the bathroom, remove the drywall and the insulation baffles between the trusses above the bath area. Seal the area between the exterior face of the top plates and the roof sheathing with rigid insulation so that exterior air entering through the soffit can not wash through the insulation. Either place fiberglass batt insulation prior to the installation of drywall or loose fill insulation after the drywall is installed. Make sure there is plenty of insulation above the top plates in this area.
4. Replace the bathroom fan with a high quality unit that exhausts at least 70 CFM (preferably more) and is vented to the exterior. Make sure everything is covered with insulation after the bath fan and duct work is installed. The ductwork should also be insulated to avoid condensation inside the duct.
5. Currently the bath fan duct exhausts through a small soffit vent (Figure 9). The vent is far too small and constricts the flow of air. A properly sized roof cap, wall cap, or soffit vent should be installed. The cap should have a back-draft damper to keep cold air from blowing into the duct. The duct should be insulated to keep warm moist air from condensing inside the duct.
6. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
7. Inform the homeowner that the bath fan grill should occasionally be vacuumed to keep the air intake holes free of lint and dust.
8. When not in use, keep the bath door open so that heat and air can migrate into the room, or use the electric heater to keep the room warm. Keeping the room warmer will help mitigate mold problems.
9. Clean mold from windows sills and draw window coverings back during daytime hours to allow air to circulate over glass.



Figure 9: Bath exhaust in soffit

10. Use electric in-wall heaters in bedrooms to increase wall surface temperatures, or use a dehumidifier to lower the humidity in these rooms.
11. Replace the dryer duct in the crawl space.
12. Identify where the plumbing is leaking and repair.
13. Install a minimum of 1" thick rigid insulation tight to the subfloor at each crawl space vent extending approximately 2' beyond the rim joist.
14. Remove the clutter in the crawl space, or place it in sealed plastic containers. Clutter in the crawl space provides food for mold to grow on if the humidity gets high enough.
15. Repair or replace the non-functioning kitchen range hood.
16. Repair hole in roof.
17. To remedy the condensation on the toilet tank, install a mixing valve or an insulated toilet tank.

Inspection Number: 1-5
Address: 6370 Lookout site Rd. #65
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Wood Stove (Primary) and Electric In-Wall Heaters (Not Used) on Exterior Walls
Bedrooms: 3
Occupancy: 3 Adults
Age: 21 Years

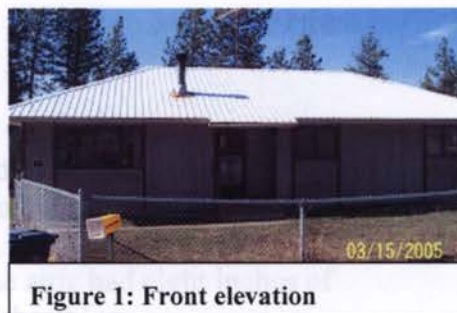


Figure 1: Front elevation

Mold and Moisture Conditions: Mold was present in the bathroom at the wall to ceiling junction (Figure 2) and on the attic sheathing (Figure 3).



Figure 2: Mold at wall to ceiling junction in bathroom

Site Drainage and Rainwater Management: The site drained away from the home. The fire hydrant in front of the home was leaking, saturating the ground surrounding it (Figure 4). The neighborhood, built on impermeable decomposed granite, received runoff from a nearby hill and several crawl spaces in the neighborhood have in the past had water problems. The installation of French drains around some homes has helped mitigate the crawl space flooding.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space had standing water in it. The walls were insulated with rigid insulation some of which had fallen to the floor (Figure 5). Crawl space vents were present.



Figure 4: Leaking fire hydrant in front of house

Exterior Conditions: The metal roof and wood siding were in good condition. No gutters were present.



Figure 3: Mold on attic sheathing



Figure 5: Water in the crawl space and loose insulation

Bathroom: The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, was in good condition.

Mold was present on the drywall above the tub/shower at the wall to ceiling junction.

Kitchen: The kitchen was not viewed.

Interior Conditions: The interior of the unit was in good condition. Upon entry to the home, a dank odor was detected which was probably from the flooded crawl space.

Attic: The attic hatch was insulated. The remainder of the attic had eight inches of cellulose insulation. Minor mold was visible on the roof sheathing.

Occupant Notes: Three adults lived in the home. None reported health problems. There were no smokers in the home.

Discussion/Recommendations:

On the Exterior:

1. Repair fire hydrant/water main.

On the Interior:

1. Clean and paint moldy drywall above tub/shower.
2. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report]. Advise occupants to always use the fan when bathing.
3. The bath fan exhaust was not inspected. Make sure the bath fan is properly vented to the exterior and that the vent is not undersized.
4. Remove the vapor barrier in the crawl space so that the water can drain into the soil and open the crawl space vents. Once the fire hydrant leak has been repaired and the soil has dried out, replace the vapor barrier.
5. Replace the rigid insulation on the stem wall in the crawl space.
6. Inspect the rest of the crawl space to make sure the rim joist is properly insulated.
7. The source of moisture that caused the mold on the roof sheathing could be from construction, or moisture from the crawl space, or the bath fan. As long as the source of moisture is eliminated, the roof sheathing should be ok. Seal all penetrations through the subfloor and bottom plates to eliminate any migration of moisture from the crawl space into the attic. Make sure the bath fan and range hood are properly vented to the exterior.

Inspection Number: 1-6
Address: 5570 Sadie St.
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Electric In-Wall Heaters (Primary)
on Exterior Walls and Wood Stove
(Not Used)
Bedrooms: 3
Occupancy: 1 Adult and 2 Children
Age: 25 Years

Mold and Moisture Conditions: Mold was present in the bathroom (Figure 2), at the base of walls in exterior corners in the bedrooms (Figure 3), and in the crawl space.

Site Drainage and Rainwater Management: The site, relatively flat, drained away from the house. Gutters were poorly maintained and were missing downspouts, leaders and full of pine needles.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space was dry, and a vapor barrier was present. The stem wall and band joist were insulated, but sections of the band joist insulation were missing in locations difficult to access because of the joists layout. Mold had formed at these locations. No vents were present. Instead, a ventilation system drew air from the habitable spaces into the crawl space and exhausted it into the attic. See the Technical Section of this report for a more complete description of this ventilation scheme. The dryer duct appeared intact, however, based on the amount of lint on the surrounding cobwebs probably leaked into the crawl space (Figure 4).

Exterior Conditions: The metal roof was in good condition. The gutters were full of pine needles and appeared to be peeling away from the fascia board (Figure 5). The vinyl siding was cracked in



Figure 1: Front elevation



Figure 2: Mold at wall to ceiling junction above bathtub



Figure 3: Mold at base of wall in exterior corner



Figure 5: Gutters full of pine needles



Figure 4: Dryer vent - note lint on cobwebs

several places (Figure 6).

Bathroom: The toilet, replaced a year ago, was securely fastened to the floor. The bathroom fan, operated by a separate switch, was not operable (Figure 7). Mold was present on the drywall above the tub/shower. The junction where the vinyl flooring butted up to the bathtub was compromised and allowed water into the floor system. The tub spigot was leaking (Figure 8).

Kitchen: The electric stove had a range hood exhausting to the exterior. The kitchen sink plumbing had had a leak but appeared repaired (Figure 9). The base cabinet appeared either moldy, dirty or both.

Interior Conditions: The interior of the unit was in moderate condition. Mold at thermal bridges was present on exterior walls. Condensation was reported on all windows all year long. The occupant stated that the house felt very muggy during the summer months.

Attic: The attic hatch was insulated. The attic had eight inches of cellulose insulation. The ventilation system for the crawl space was located in the attic. The cellulose insulation surrounding the ventilation unit had been wetted in the past (Figure 10). The duct for the bathroom fan was uninsulated (Figure 11).

Occupant Notes: One adult and two children lived in the home. All reported health problems: the two children had allergies and the



Figure 6: Cracked vinyl siding



Figure 7: Inoperable bath fan



Figure 10: Formerly wet insulation in attic next to crawl space ventilator



Figure 8: Tub spigot and overflow



Figure 9: Former leaky kitchen plumbing



Figure 11: Uninsulated bath fan duct

adult had chronic sinus infections and headaches. There were two smokers in the home.

Discussion/Recommendations:

On the Exterior:

1. Repair the vinyl siding.
2. Remove the gutter system.

On the Interior:

1. Poor heat distribution and a non-functional exhaust fan have contributed to the bathroom mold problem.
2. The mold on the ceiling above the tub should first be scrubbed with soap and water to see if it can be removed. If the mold has compromised the paper face of the drywall, the drywall will need to be removed.
3. After removing the loose-fill insulation in the attic above the bathroom, remove the drywall and the insulation baffles between the trusses above the bath area. Seal the area between the exterior face of the top plates and the roof sheathing with rigid insulation so that exterior air entering through the soffit can not wash through the insulation. Either place fiberglass batt insulation prior to the installation of drywall or loose fill insulation after the drywall is installed. Make sure there is plenty of insulation above the top plates in this area.
4. Replace the bathroom fan with a high quality unit that exhausts at least 70 CFM (preferably more) and is vented to the exterior. Make sure everything is covered with insulation after the bath fan and duct work is installed. The ductwork should also be insulated to avoid condensation inside the duct.
5. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
6. When not in use, keep the bath door open so that heat and air can migrate into the room. Keeping the room warmer will help mitigate mold problems.
7. Reseal the junction between the vinyl flooring and the bathtub.
8. Repair leaking tub spigot.
9. The mold at the base of the wall in the bedroom corners appears to be beyond simple cleaning. The drywall will need to be removed to properly repair this area. Remove the drywall, allow the interior of the wall to dry, make sure everything is well insulated, and patch the drywall.

10. The mold in the bedroom corners was partially caused by the uninsulated band joist. The lack of insulation below these areas allowed the walls to become cold and susceptible to mold. Furniture placed in the corners did not allow air to circulate in the corner and further cooled and isolated the corners.
11. The band joist needs to be insulated. Since access is a problem, spray foam would probably be the best option for insulating this area. See the technical section of the report for more on this topic.
12. The crawl space ventilation system should be disabled. See the Technical section of the report for a more detailed discussion regarding the concerns with the existing system.
13. Seal all dryer duct joints with duct mastic or metal duct tape. Do not use standard duct tape. Standard duct tape rapidly dries out, loses its seal and fails.
14. Clean mold from windowsills and draw window coverings back during daytime hours to allow air to circulate over glass.
15. Use electric in-wall heaters in bedrooms to increase wall surface temperatures, or use a dehumidifier to lower the humidity in these rooms.

Inspection Number: 1-7
Address: 5597 Albert Sam Avenue
Model Type: Split Level
Foundation: Concrete basement and crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Wood Stove (Primary) and Electric In-Wall Heaters (Secondary) on Interior Walls
Bedrooms: 3
Occupancy: 1 Adult
Age: 22 Years

Mold and Moisture Conditions:

Mold was present in the lower level bathroom (Figure 2) and in the basement at the base of an exterior wall (Figure 3).

Site Drainage and Rainwater Management:

The site, relatively flat, drained away from the home. However, depressions were present near the foundation (Figure 4). Gutters were not present.

Foundation Conditions: The home rested on a concrete foundation. A portion of the residence was partially sub-grade and the rest of the home had a deep crawl space.

Crawl Space and Basement Conditions: The crawl space was dry, though no vapor barrier was present. The walls and band joists were insulated, however sections of the band joist insulation appeared to have fallen from place. Vents were present. Mold was present along an exterior basement wall. There was water damage to the wood window sashes due to condensation (Figure 5).

Exterior Conditions: The metal roof and wood siding were in good condition. No gutters were present. A section of soffit material was missing and other sections were loose (Figure 6).



Figure 1: Front elevation



Figure 3: Note mold, insulation and crawl space vent on floor



Figure 2: Mold at wall to ceiling junction in bathroom



Figure 4: Depression next to foundation



Figure 6: Failing soffit material



Figure 5: Window sash deterioration due to condensation

Bathroom: The basement toilet wiggled. The bath fan, operated by a separate switch, exhausted with low efficacy to the exterior. In the downstairs bathroom, mold was present on the drywall above the tub/shower. The upstairs bathroom was not inspected.

Kitchen: The kitchen was not viewed.

Interior Conditions: The interior of the unit was in good condition. Damage due to condensation was evident on basement windows, and mold was present along the base of an exterior basement wall.

Attic: The attic was not viewed.

Occupant Notes: One adult lived in the home. She reported ongoing sinus problems; she also smoked.

Discussion/Recommendations:

On the Exterior:

1. Repair soffit.
2. Fill and re-grade depressions near the foundation.
3. Replace the undersized bathroom vent with an appropriately sized wall vent for the lower bathroom (Figure 7), and an appropriately sized soffit vent for the upstairs bathroom. Both vents should have a back-draft damper.



Figure 7: Lower level bath vent exhaust

On the Interior:

1. Clean and paint molded drywall above tub/shower. The mold could be due to a combination of poor ventilation and marginal insulation between the floor joists', next to the band joist. Removal of drywall would only be warranted if this problem persisted after a properly exhausting bath fan is installed. Increased ventilation will hopefully remedy the problem.
2. Replace the exhaust fan in both bathrooms with a high quality, low sone unit.
3. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
4. When not in use, keep the bath door open so that heat and air can migrate into the room. Keeping the room warmer will help mitigate mold problems.
5. Replace wax seal and tighten toilet to basement floor.

6. Install vapor barrier in crawl space.
7. Replace missing band joist insulation in the crawl space
8. Clean and repaint molded drywall at base of walls in basement. Make sure there are no depressions next to the foundation where these walls are moldy. Proper drainage around the habitable portions of the house that are partially sub grade is important. Currently, the amount of mold at the base of these walls does not warrant drywall removal.
9. Wash, lightly sand, and apply polyurethane to the basement windows frames and sash. If condensation continues to plague these windows, run a dehumidifier to lower the humidity. An additional benefit of running a dehumidifier would be that it would provide some heat to the space.

Foundation Condition: The unit is situated on a concrete crawl space foundation.

Crawl Space:

The crawl space is

approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

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approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

wide and 10' deep.

The crawl space is

approximately 10'

wide and 10' deep.

Inspection Number: 2-1
Address: 6441 Molly Court
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Electric In-Wall Heaters (Only) on Exterior Walls
Bedrooms: 4
Occupancy: 2 Adults and 2 Children
Age: 24 Years

Mold and Moisture Conditions: No evidence of mold was in this home.

Site Drainage and Rainwater Management: The site drained away from the home. However, depressions were present near the foundation. Gutters were not present.

Foundation Conditions: The home rested on a concrete crawl space foundation.

Crawl Space Conditions: The crawl space was dry with a vapor barrier present. The walls and band joist were insulated, though sections of the band joist insulation were missing (Figures 2 & 3).



Figure 3: Missing band joist



Figure 1: Front elevation



Figure 2: Missing band joist insulation

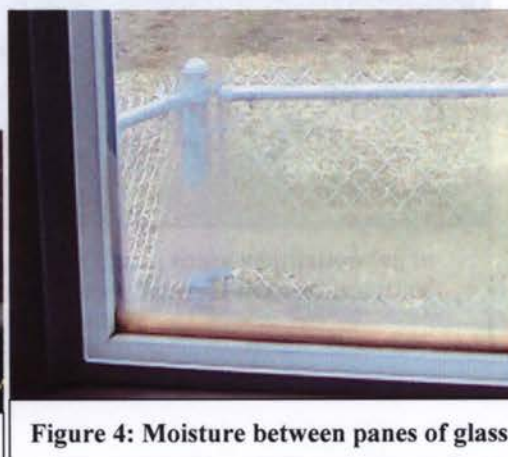


Figure 4: Moisture between panes of glass

Exterior Conditions: The metal roof and vinyl siding were in good condition. One of the thermo pane windows had lost its seal (Figure 4). No gutters were present.

Bathroom: The toilet was securely fastened to the floor. The bathroom fan was in good condition, was operated by a separate switch and exhausted to the exterior. There was an uninsulated bathroom duct in the attic (Figure 5).

Kitchen: The kitchen sink had a minor leak and was fixed during the assessment. The electric stove had a re-circulating range hood.



Figure 5: Uninsulated bathroom duct in the attic

Inspection Number: 3-2

Interior Conditions: The interior was in excellent condition, having been renovated last fall. Previous tenants complained of mold related health issues, but nothing was found during renovation. Current tenants reported no mold, but that some moisture condenses on windows during winter. There was no dryer, and the washing machine leaked onto the floor.

Attic: The attic hatch was insulated. The remainder of the attic had eight inches of cellulose insulation. The bath fans were vented to the outside through smooth metal uninsulated ducts. The ventilation system for the crawl space was located in the attic. The cellulose insulation surrounding the ventilation unit had been wetted in the past (Figure 6).

Occupant Notes: Two adults and two children lived in the home. One child suffered from allergies, a condition present before occupying the unit three months ago. Two smokers lived in the home.

Discussion/Recommendations:

On the Exterior:

1. Fill and re-grade depressions near the foundation.

On the Interior:

1. In crawl space, replace missing insulation sections along the perimeter band joist and insulate those areas that were never insulated.
2. Repair washing machine leak.
3. Replace re-circulating kitchen exhaust fan with one vented to the exterior.
4. The crawl space ventilation system should be disabled. See the Technical Section of the report for a more detailed discussion regarding the concerns with the existing system.



Figure 1: Crawl space ventilation fan in attic, note evidence of wetted insulation around unit

Inspection Number: 2-2

Address: 6440 Molly Court

Model Type: Ranch

Foundation: Concrete crawl space

Construction: 2 x 6 Wood Frame

Heat Type: Wood Stove (Primary) and Electric In-Wall Heaters (Secondary) on Interior Walls

Bedrooms: 3

Occupancy: 1 Adult and 2 Children

Age: 24 Years

Mold and Moisture Conditions: Mold was present in the bathroom (Figure 2), on window sills (Figure 3) and in the crawl space (Figure 4).

Site Drainage and Rainwater Management: The site drained away from the home. However, depressions were present near the foundation (Figure 5& 6). Gutters were not maintained and were missing downspouts and leaders and were also full of pine needles (Figure 7).

Foundation

Conditions: The home rested on a concrete crawl space foundation.

Crawl Space

Conditions: The crawl space was dry, and a vapor barrier was present. The stem walls and band joist were insulated, though sections were missing. There was evidence



Figure 1: Front elevation



Figure 2: Minor mold above bathtub surround



Figure 3: Water damage to window sash and sill



Figure 4: Moldy cardboard in crawl space



Figure 5: Puddle in a depression next to the foundation wall



Figure 6: Broken dryer exhaust and depression next to foundation



Figure 7: Missing downspout and pine needles in gutter

of a former plumbing leak. Clutter (Figure 8) and bat skeletons were present.

Exterior Conditions: The metal roof was in good condition. The vinyl siding was cracked and damaged in several places (Figure 9). The dryer vent was broken (Figure 6).

Bathroom: The toilet was securely fastened to the floor. The bathroom fan, operated by a separate switch, was exhausting with low efficacy to the exterior. There was an open gap between the vinyl flooring and the bathtub (Figure 10). Mold was present on the drywall above the tub/shower.

Kitchen: The electric stove had a range hood exhausting to the exterior.

Interior Conditions: The interior of the unit was in good condition. A disconnected dryer duct was reconnected one year ago.

Attic: The attic hatch was insulated. The remainder of the attic had eight inches of cellulose insulation. The bath fan was vented to the outside with smooth uninsulated metal ducting (Figure 11). The ventilation system for the crawl space was located in the attic.

Occupant Notes: One adult and two children lived in the home. Occupants were not present for interviewing.

Discussion/Recommendations:

On the Exterior:

1. Fill and re-grade depressions near the foundation.
2. Repair vinyl siding.
3. Remove gutter system.
4. Fix the broken dryer vent exhaust.



Figure 8: Food for mold in crawl space



Figure 9: Damaged vinyl siding



Figure 10: Open seam between vinyl flooring and bathtub



Figure 11: Uninsulated bathroom fan duct

On the Interior:

1. Replace missing insulation sections in crawl space.
2. Replace bathroom exhaust fan and insulate the duct in the attic.
3. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
4. Fix the junction between the vinyl flooring and the bathtub.
5. Clean the mold from the bath walls with soap and water, allow to dry, and repaint with a mildew resistant paint such as Zinsser semi-gloss Perma-White paint. See the following website for further information on this product:
www.zinsser.com/product_detail.asp?ProductID=35
6. Wash, lightly sand, and apply polyurethane to the windows frames and sash. If condensation continues to plague these windows, run a dehumidifier to lower the humidity. An additional benefit of running a dehumidifier would be that it would provide some heat to the space.
7. The crawl space ventilation system should be disabled. See the Technical section of the report for a more detailed discussion regarding the concerns with the existing system.
8. Remove clutter, bat skeletons, and tree roots from crawl space. The clutter provides food for mold to grow on. If personal goods are to be stored in the crawl space, use air tight plastic containers to store goods inside.

Inspection Number: 2-3
Address: 6444 Selena Court
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Electric In-Wall Heaters (Primary) on Exterior Walls/Wood Stove (Not Used)
Bedrooms: 3
Occupancy: 2 Adults and 2 Children
Age: 21 Years

Mold and Moisture Conditions: Mold was present in the bathroom (Figures 2 & 3).

Site Drainage and Rainwater Management: The site, relatively flat, drained away from the home. However, depressions were present near the foundation. Gutters were poorly maintained with missing downspouts and leaders, and full of pine needles.



Figure 1: Front elevation



Figure 2: Mold on walls and ceiling above bathtub



Figure 3: Mold on exterior wall next to toilet



Figure 4: Actively leaking water meter in crawl space



Figure 5: Evidence of water leakage

Foundation Conditions: The home rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Conditions: The crawl space was dry, and a vapor barrier was present, as was evidence of former flooding. The water meter was actively leaking (Figure 4) and the vapor barrier had been cut to allow the water to drain into the soil. There was evidence of a former leak from above in the kitchen (Figure 5). The walls and band joists were insulated.

Exterior Conditions: The metal roof and wood siding were in fairly good condition except for mildew around the bath vent on the soffit. The frost-free water spigot was leaking (Figure 6).

Bathroom: The toilet was not fastened tightly to the floor and there was mold on the wall next to it (Figure 3). The bath fan, operated by a separate switch, was exhausting with very low efficacy to an undersized round vent in the soffit (Figure 7). Mold was present on the bath walls and ceiling. Occupants reported opening the window during showers.



Figure 6: Leaking spigot



Figure 7: Bathroom vent next to bath window

Kitchen: The electric stove had a range hood exhausting to the exterior. The kitchen sink waste plumbing was leaking and there was standing water on the cabinet base (Figure 8). The laundry room sink was also leaking; both were fixed during our assessment.



Figure 8: Standing water in base of kitchen cabinet

Interior Conditions: The interior of the unit was in moderate condition. There was moisture damage to window sashes and sills and windows had heavy window coverings (Figure 9). One of the thermopane windows had lost its seal.

Attic: The attic hatch was insulated and there was approximately eight inches of cellulose insulation in the attic.

Occupant Notes: Two adults and two children lived in the home. One occupant is a smoker.

Discussion/Recommendations:

On the Exterior:

1. Fill and re-grade depressions near the foundation.
2. Repair leaking spigot.
3. Remove gutter system.
4. Clean and repaint molded soffit section.



Figure 9: Heavy window covering, moisture between panes of glass, and moisture damage to sash and sill

On the Interior:

1. Replace bathroom exhaust fan and insulate the duct in the attic.
2. Install a timer or time-delay switch for the bath fan [as described in the technical section of the report].
3. Replace the undersized bath vent in the soffit with an appropriately sized vent with a back-draft damper.
4. Clean the mold from the bath walls with soap and water, allow to dry, and repaint with a mildew resistant paint such as Zinsser semi-gloss Perma-White paint. See the following website for further information on this product:
www.zinsser.com/product_detail.asp?ProductID=35
5. Wash, lightly sand, and apply polyurethane to the window frames and sash. If condensation continues to plague these windows, run a dehumidifier to lower the humidity. An additional benefit of running a dehumidifier would be that it would provide some heat to the space.
6. Replace wax seal beneath toilet and secure toilet to floor.
7. Replace window with compromised seal.
8. Fix leaking water main in crawl space.